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SHELTER UPGRADING MANUAL: HOST AREA SHELTERS, REVISIONS AND ADD--ETC(U)
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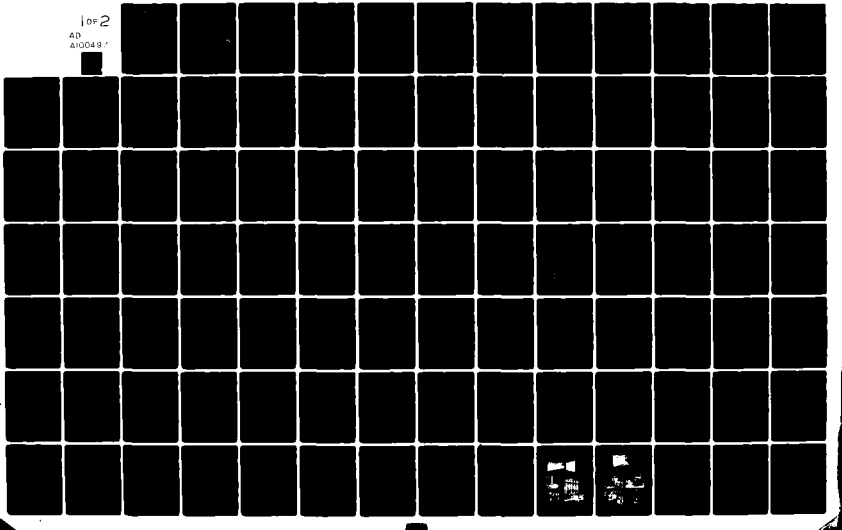

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REVISIONS AND ADDITIONS
to
Shelter Upgrading Manual: Host Area Shelters

by

C. Wilton, B.L. Gabrielsen, and R.S. Tansley

JUN 23 1981

for

Federal Emergency Management Agency
Washington, D.C. 20472

Contract No. EMW-C-0153, Work Unit 1128A
(originally Work Unit 1127H)
Dr. Michael A. Pachuta, Project Officer

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blast protection; civil defense; crisis relocation planning; fallout protection; host area; manual; shelter; upgrading

20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Shelter Upgrading Manual: Host Area Shelters, which was originally developed under Contract No. DCPA01-78-C-0215, Work Unit 1127H, is in looseleaf form to permit removal of pertinent worksheets and charts for developing upgrading plans for a specific building and to permit the addition of new and replacement material as the work progresses. The manual is one of a series being developed in support of the civil

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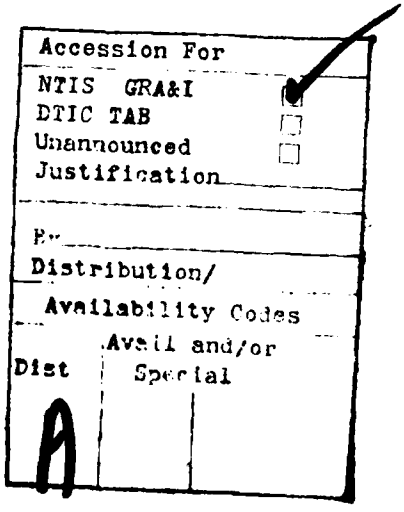
Block 20. Abstract (contd)

defense concept of crisis relocation planning and is designed to be used by planners in host areas. It presents a methodology for evaluating floors, roofs, and openings and develops a variety of ways to provide the necessary structural upgrading for blast and fallout protection.

The revisions included here are based on a testing program and are generally in the area of modified survival ratings. Additional new material on expedient shelters is included in an appendix.



SHELTER UPGRADING MANUAL: HOST AREA SHELTERS

Revisions and Additions

The Shelter Upgrading Manual: Host Area Shelters, SSI Report No. 7815-8, which was first published in March 1980, has been revised and updated. The enclosed packet of materials contains revisions of existing pages and some additional new pages.

Please make the following changes in your copy of that report:

Page	
iii/iv	Replace
1-1/1-2	Replace (page 1-1 revised)
2-5/2-6	Replace (page 2-5 revised)
2-7/2-8	Replace (page 2-8 revised)
Section 4	
Index/chart	Replace (revisions to both sides)
4-1/chart	Replace (chart on reverse side revised)
4-2/chart	Replace (chart on reverse side revised)
4-3/chart	Replace (page 4-3 revised)
4-4/chart	Replace (page 4-4 revised)
4-5/chart	Replace (chart on reverse side revised)
4-6/chart	Replace (chart on reverse side revised)
4-16/chart	Replace (new chart on reverse side)
4-16a/chart	Add new page
4-22/chart	Replace (new chart on reverse side)
4-22a/chart	Add new page
4-28/chart	Replace (new chart on reverse side)
4-29	Add new page

Revisions and Additions to SHELTER UPGRADING MANUAL: HOST AREA SHELTERS (continued)

Page	
Section 5	
Index/chart	Replace (both sides revised)
5-1/chart	Replace (chart on reverse side revised)
5-2/chart	Replace (chart on reverse side revised)
5-10/chart	Replace (new chart on reverse side)
5-11	Add new page
Section 6	
Index/resource list	Replace (index revised)
6-9/resource list	Replace (page 6-9 revised)
6-10/resource list	Replace (page 6-10 revised)
6-20a/resource list	Add new page
6-20b/resource list	Add new page
6-39/resource list	Replace (new resource list on reverse side)
6-40/resources list	Add new page
6-41	Add new page
Appendix B	
B-1/B-2	Replace (page B-1 revised)
B-11 to B-17	Add new pages
Appendix D	
D-1 to D-32	Add new Appendix

Table of Contents

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Glossary and List of Notations

As built —
Structure prior to upgrading

Host area —
Area that is subjected to blast pressures of 2 psi or less

Key worker area —
Area that is subjected to blast pressures greater than 30 psi

Overpressure —
Pressure caused by blast

Protection factor —
Factor that compares degree of radiation protection to zero protection

Protection factor key —
Earth thickness in feet required to obtain specified radiation protection

Risk area —
Area that is subjected to blast pressures from 2 psi to 30 psi

Shelter rating —
Rating given a shelter, in roman numerals, corresponding to a given overpressure (see Fig. 1-1)

Survival rating —
95% probability of survival for a structure of a given shelter rating

psf	pounds per square foot
psi	pounds per square inch
kPa	kilopascal (psi times 6.895)
S_R	survival rating
P_f	protection factor
I	shelter rating - 40 psi overpressure
II	shelter rating - 30 psi overpressure
III	shelter rating - 20 psi overpressure
IV	shelter rating - 10 psi overpressure
V	shelter rating - 5 psi overpressure
VI	shelter rating - 2 psi overpressure
VI^+	slightly better than a VI shelter rating (used for all shelter ratings)
VI^-	slightly less than a VI shelter rating (used for all shelter ratings)
N	no additional radiation protection required
"0"	provides no blast survival
†	depth of earth required for radiation protection would cause collapse

Revised - 5/81

Section 1
INTRODUCTION

This manual is intended for use in the identification of and the upgrading, if required, of shelter spaces to support Crisis Relocation Planning. Concern is limited here to shelters in the "host" areas, where it is assumed blast overpressures do not exceed 2 psi and radiation protection equivalent to 18 in. of earth is adequate.

The manual is organized as follows: Section 2 will assist in the selection and identification of potential shelter facilities. Section 3 explains the use of the manual and the selection of methods for upgrading with examples. Sections 4 and 5 contain the key charts on the upgrading of various floors and roofs. Section 6 contains sketches of the various upgrading methods and the resources required for each. Section 7 has the various worksheets for each method. Section 8 includes the charts necessary for sizing the shoring required for the upgrading method selected. At the end of the manual, appendices containing supplemental information are provided. Appendix A assists in the evaluation of a structure for use as a potential shelter. Appendix B provides data and charts for closing small openings. Appendix C illustrates alternative types of shoring systems. Appendix D covers expedient shelter options.

The manual is in looseleaf format for two reasons: (1) Use of the manual requires that worksheets and data sheets be removed to develop upgrading plans for a specific building; and (2) In its present form the manual is far from complete, and replacement or new pages and sections, which are being developed by SSI, will be supplied for insertion when available. Included in this new information will be additional upgrading schemes for floors and roofs, based on upcoming full-scale tests of floor and roof systems;

procedures for upgrading walls of aboveground shelters; a more extensive closure section; and the necessary information for calculating required supplemental equipment such as ventilation, water and sanitation kits.

It should also be noted that the manual is one of a series that will also consider key worker and risk area shelters. In these other manuals higher overpressures will be considered, and shelters will be ranked by survival ratings "as built" and for the various upgrading schemes. Shelters will be rated for selected overpressures, and each shelter rating will carry a roman numeral designation corresponding to a particular overpressure. A pictorial representation of the relationship between shelter rating, overpressure, and the key worker, risk, and host areas is shown in Fig. 1-1. As mentioned above, this manual confines itself to VI shelter rating or a maximum of 2 psi overpressure, which is defined as a host area shelter.

Table 2-2

FLOOR SYSTEM COLLAPSE LOADS[1] psf (psi)

Live Load / Floor Type and Dead Load (D.L.)	LIGHT (L) 50 psf (40 - 60 psf)	MEDIUM (M) 100 psf (80 - 125 psf)	HEAVY (H) 200 psf (150 - 250 psf)
Wood (W) Construction (D.L. = 20 psf)	92 (0.6) soil[2] 155 (1.1) blast[3]	172 (1.2) soil[2] 280 (1.9) blast[3]	332 (2.3) soil[2] 530 (3.7) blast[3]
Steel, Light (SL) Construction (D.L. = 30)	105 (0.7)	190 (1.3)	does not exist
Steel, Heavy (SH) Construction (D.L. = 80)	140 (1.0)	225 (1.6)	395 (2.8)
Concrete (C) Construction (D.L. = 100)	200 (1.4)	300 (2.1)	500 (3.5)

Notes

(1) Load increase factors are 1.7 for steel, and 2.0 for concrete, respectively. The 1.7 for steel assumes a truss support system.

(2) Load increase factor for static load (soil) for timber is 1.6.

(3) Load increase factor for dynamic load (blast) for timber is 2.5.

Table 2-3

FLOOR SAFETY RATING TABLE FOR AS BUILT CONSTRUCTIONS

WITH P_f = 100 (18 in. soil) AND S_R = VI (2 psi)

Type \ Loading	Light 50 psf (40 - 60 psf)	Medium 100 psf (80 - 125 psf)	Heavy 200 psf (150 - 250 psf)
Wood Construction	Upgrading required, see Section 3	Upgrading required, see Section 3	"OK" as built
Steel Light Construction	Upgrading required, see Section 3	Upgrading required, see Section 3	Does not exist
Steel Heavy Construction	Upgrading required, see Section 3	Upgrading required, see Section 3	"OK" as built
Concrete Construction	Upgrading required, see Section 3	Upgrading required, see Section 3	"OK" as built

ROOF SYSTEM ANALYSIS

A similar analysis can be applied to roof systems. It is assumed that the roof systems of interest are relatively flat and that the radiation upgrading can be accomplished by adding soil. Table 2-4 provides the results of the analysis in force units.

There are no roof systems that, without upgrading, will have an S_R = VI (2 psi plus 18 in. soil). Refer directly to Section 3 of the manual for the appropriate methods of upgrading.

Table 2-4

ROOF SYSTEM ANALYSIS

Column 1	Column 2	Column 3	Column 4	Column 5
Roof Type	Design Live Load	Design Dead Load	Load Increase Factor	Collapse[4] Load [5]
	psf	psf	psf	psf (psi)
Wood (W)	15	15	1.6 2.5	33 (0.2) soil 60 (0.4) blast
Steel[1] (SL) Light Construction	15	25	1.7[3]	45 (0.3) soil or blast
Steel [2] (SH) Heavy Construction	15	60	1.7[3]	65 (0.4) soil or blast
Concrete (C)	15	80	2.0	110 (0.8) soil or blast

Notes

(1) Light steel construction assumes a steel support structure and a timber sheathing system.

(2) Heavy steel construction assumes a steel support structure, steel decking and a lightweight concrete topping.

(3) The 1.7 load increase factor assumes truss supports. Beams will provide a higher load increase factor.

(4) The collapse load values shown in Column 5 can be increased in snow regions by multiplying the regional design snow load minus 15 psf by the safety factor and adding to Column 5.

(5) If a roof structure is used for parking or some other activity, analyze it as a floor system.

INDEX

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WOOD CONSTRUCTION - FLOOR

SURVIVAL RATING VI

TIMBER JOIST-LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	1	VI$^+$	Page 6-1	Page 8-1	Page 7-1
	100	1.5	VI			
	1000	3	0			
Post and Beam Shores at Mid-span	40	1	VI$^+$	Page 6-2	Page 8-2, 8-3	Page 7-2
	100	1.5	VI			
	1000	3	0			
King Post Truss	40	1	VI	Page 6-3		Page 7-3
	100	1.5	0			
	1000	3	†			
Flange	40	1	VI$^-$	Page 6-4		Page 7-4
	100	1.5	0			
	1000	3	†			
Boxed Beam	40	1	VI$^-$	Page 6-5		Page 7-5
	100	1.5	0			
	1000	3	†			

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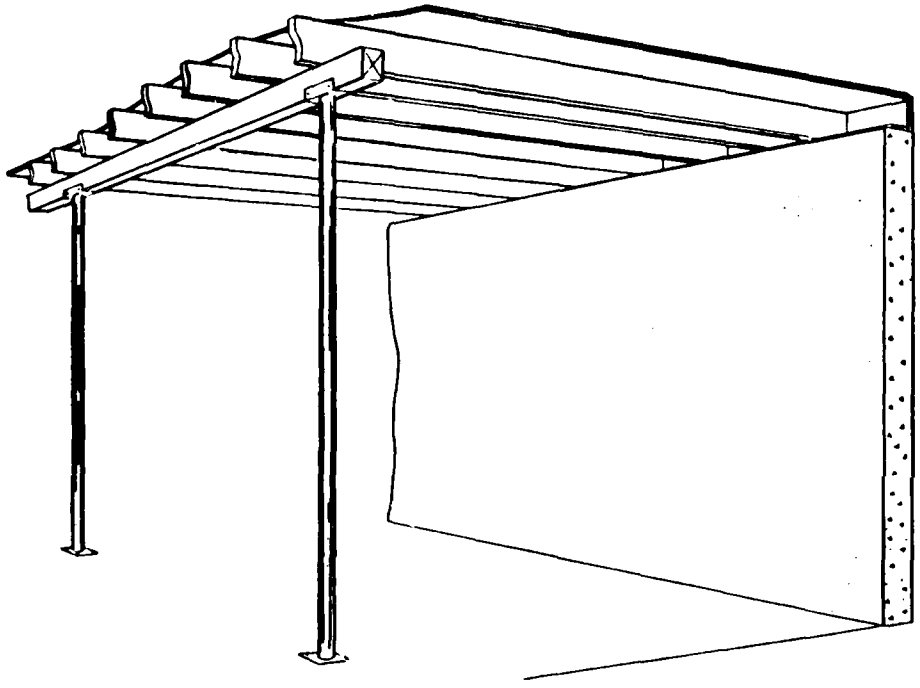

TYPICALLY FOUND IN RESIDENTIAL BASEMENTS AND SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 6 FT TO 18 FT, DEPTH OF JOIST 6 IN. TO 12 IN.

SUPPORT BEAM CAN BE EITHER STEEL OR WOOD, AND SUPPORT POSTS WOOD OR STEEL PIPE.

DESIGN CRITERION 40 - 60 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	†
1000	-	-

WOOD CONSTRUCTION–Floors

TIMBER JOIST–Light Design

AS BUILT

WOOD CONSTRUCTION - FLOOR

SURVIVAL RATING VI

GLULAM-LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-6	Page 8-1	Page 7-1
Post and Beam Shores at Mid-span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-7	Page 8-2, 8-3	Page 7-2
King Post Truss	40 100 1000	1 1.5 3	VI 0 †	Page 6-8		Page 7-3

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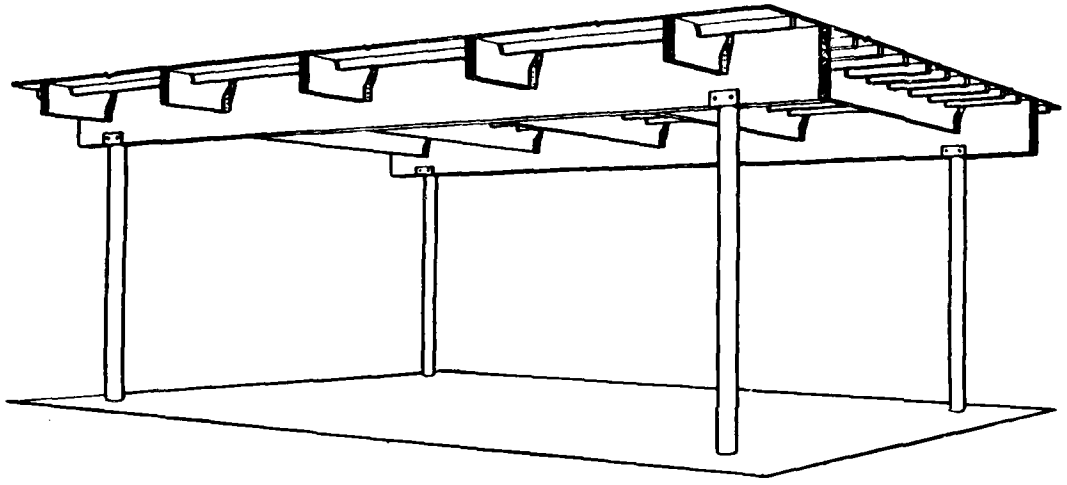

TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 6 FT TO 18 FT, DEPTH OF GLULAM JOIST 4 IN. TO 8 IN., SUPPORTED ON GLULAM BEAM, NORMALLY 8 IN. TO 16 IN. DEEP.

SUPPORT POSTS WOOD OR STEEL PIPE.

DESIGN CRITERION 40 - 60 PSF

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	+
1000	-	-

WOOD CONSTRUCTION–Floors

GLULAM – Light Design

AS BUILT

WOOD CONSTRUCTION - FLOOR

SURVIVAL RATING VI

TIMBER JOIST-MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD-80 to 125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-1	Page 8-1	Page 7-1
Post and Beam Shores at Mid-span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-2	Page 8-2, 8-3	Page 7-2
King Post Truss	40 100 1000	1 1.5 3	VI+ VI+ VI+	Page 6-3		Page 7-3
Flange	40 100 1000	1 1.5 3	VI+ VI+ VI	Page 6-4		Page 7-4
Boxed Beam	40 100 1000	1 1.5 3	VI+ VI+ VI	Page 6-5		Page 7-5

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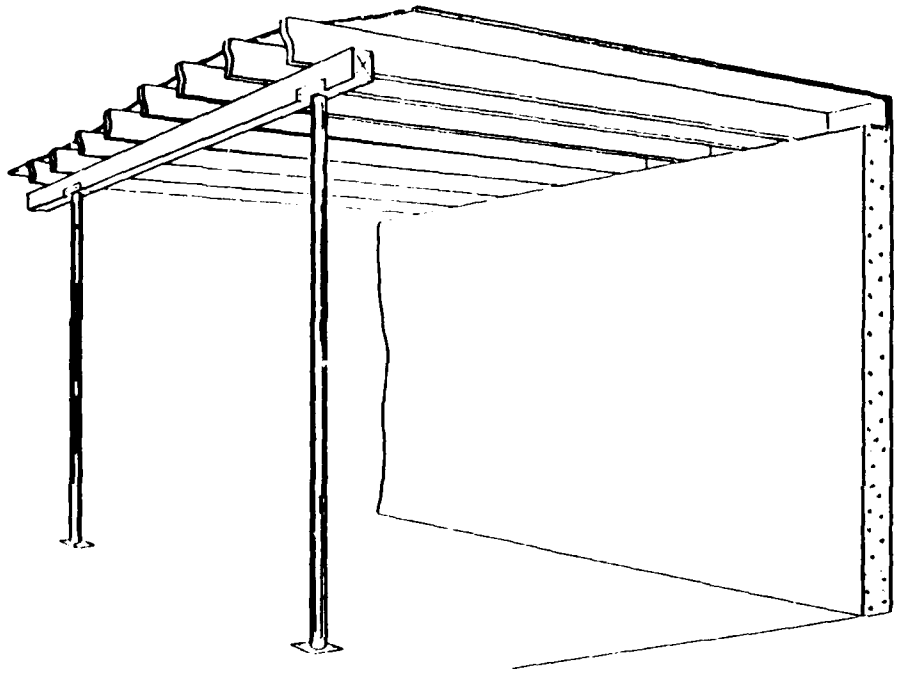


TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 6 FT TO 18 FT, DEPTH OF JOIST 6 IN. TO 12 IN.

SUPPORT BEAM CAN BE EITHER STEEL OR WOOD, AND SUPPORT POSTS, WOOD OR STEEL PIPE.

DESIGN CRITERION 80 TO 125 PSF

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	0
1000	3	†

WOOD CONSTRUCTION–Floors

TIMBER JOIST– Medium Design

AS BUILT

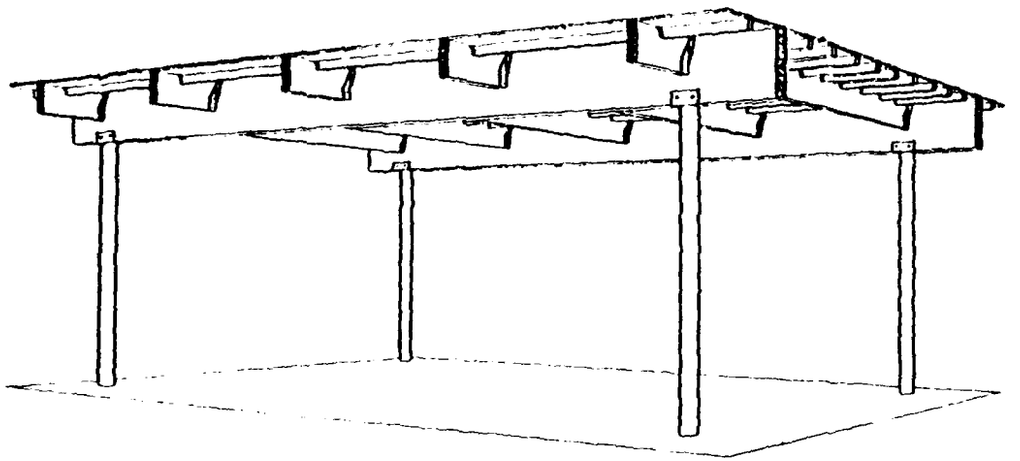
WOOD CONSTRUCTION - FLOOR

SURVIVAL RATING VI

GLULAM-MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD -80 to 125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-6	Page 8-1	Page 7-1
Post and Beam Shores at Mid-span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-7	Page 8-2, 8-3	Page 7-2
King Post Truss	40 100 1000	1 1.5 3	VI+ VI+ VI+	Page 6-8		Page 7-3



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 6 FT TO 18 FT, DEPTH OF GLULAM JOIST. 6 IN. TO 8 IN., SUPPORTED ON GLULAM BEAM, NORMALLY 8 IN. TO 16 IN. DEEP.

SUPPORT POSTS WOOD OR STEEL PIPE.

DESIGN CRITERION 80 - 125 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	0
1000	-	†

WOOD CONSTRUCTION–Floors

GLULAM – Medium Design

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AS BUILT

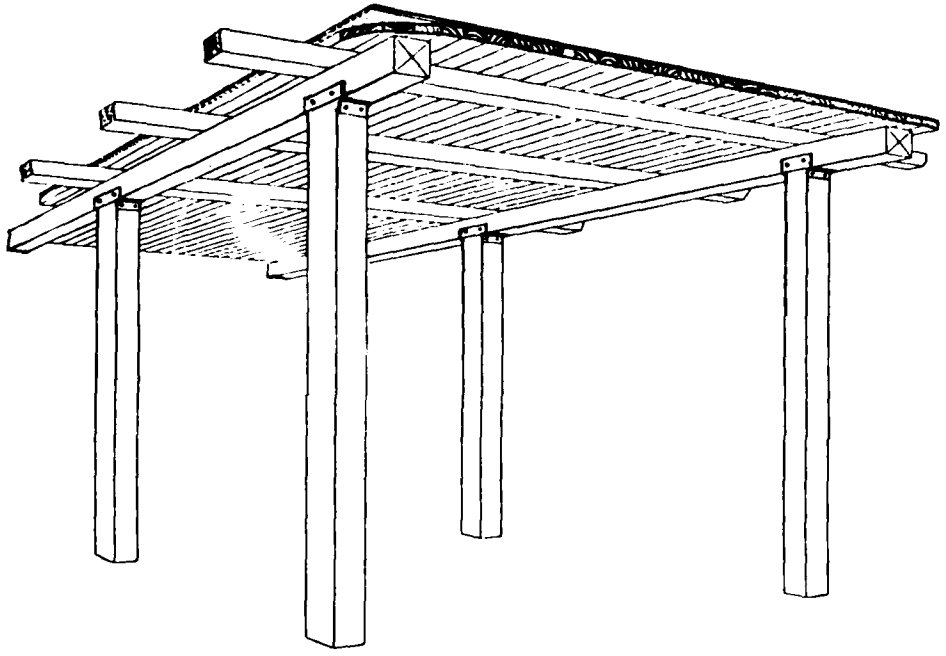
WOOD CONSTRUCTION - FLOOR

SURVIVAL RATING VI

TIMBER PLANK-HEAVY DESIGN

SUPERIMPOSED DESIGN LOAD 150 to 250 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
None Required	40	1	VI^+	DOES NOT REQUIRE UPGRADING		
	100	1.5	VI^+			
	1000	3	VI^+			



TYPICALLY FOUND IN HEAVY MANUFACTURING BUILDINGS AND STORAGE WAREHOUSES.

SPANS NORMALLY 6 FT TO 18 FT. BEAM MINIMUM 4 IN. BY 4 IN. SIZE, GIRDERS MINIMUM 8 IN. BY 8 IN. SIZE.

PLANK FLOOR MINIMUM 3 IN. TIMBER. COLUMNS USUALLY TIMBER, MINIMUM 8 IN. BY 8 IN.

DESIGN CRITERION 150 - 250 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	VI+
100	1.5	VI+
1000	3	VI+

WOOD CONSTRUCTION–Floors

TIMBER PLANK–Heavy Design

AS BUILT

STEEL - LIGHT CONSTRUCTION - FLOOR

SURVIVAL RATING VI

OPEN-WEB JOIST - LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Two rows of Wood Stud Walls, one each at 1/3 span	40 100 1000	1 1.5 3	VI^+ VI 0	Page 6-9	Page 8-1	Page 7-1
Two rows of Post and Beam Shores, one each at 1/3 span	40 100 1000	1 1.5 3	VI^+ VI 0	Page 6-10	Page 8-2, 8-3	Page 7-2

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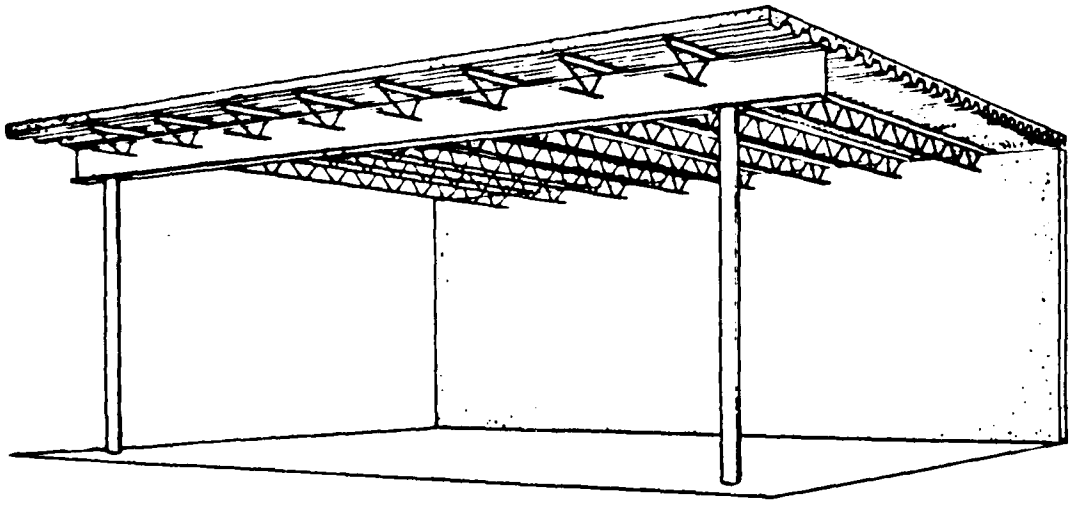

TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 8 FT TO 26 FT. OPEN-WEB JOIST DEPTH 8 IN. TO 16 IN.

SUPPORT BEAM NORMALLY STEEL.

DESIGN CRITERION 40 - 60 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	†
1000	-	-

STEEL-LIGHT CONSTRUCTION-Floors

OPEN-WEB JOIST-Light Design

AS BUILT

STEEL - LIGHT CONSTRUCTION - FLOOR

SURVIVAL RATING VI

OPEN-WEB JOIST - MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD-80 to 125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Two rows of Wood Stud Walls, one each at 1/3 span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-9	Page 8-1	Page 7-1
Two rows of Post and Beam Shores, one each at 1/3 span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-10	Page 8-2, 8-3	Page 7-2
King Post Truss	40 100 1000	1 1.5 3	VI+ VI+ 0	Page 6-11		Page 7-3

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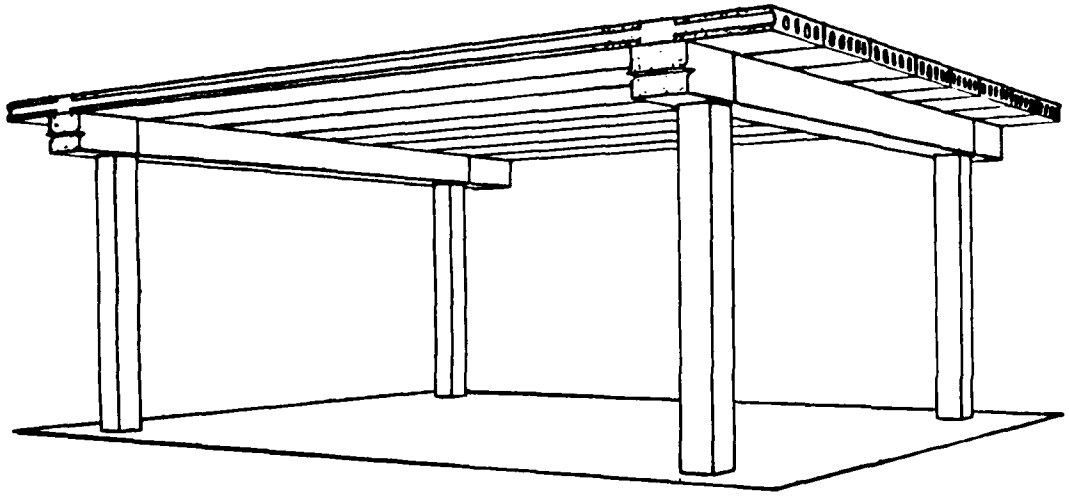


TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 12 FT TO 34 FT.

SLAB 4 IN. TO 8 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 40 TO 60 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	+

CONCRETE CONSTRUCTION–Floors

HOLLOW–CORE – Light Design

AS BUILT

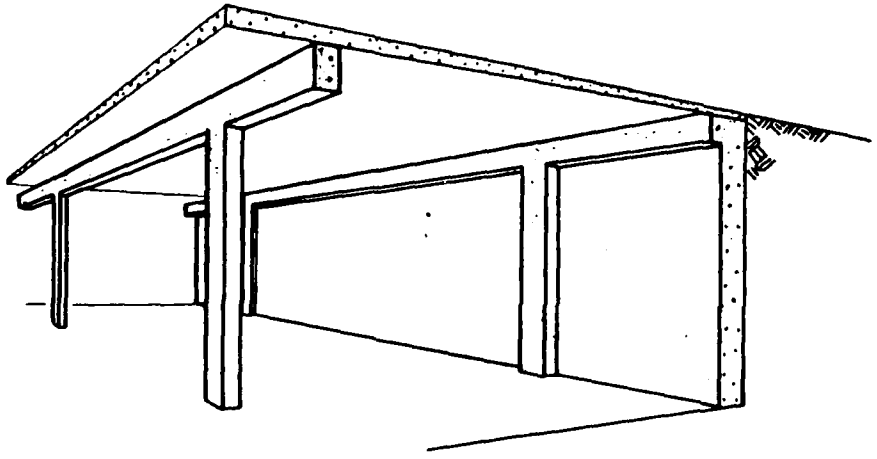
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

ONE - WAY SLAB - LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	0.5	VI+	Page 6-20A	Page 8-1	Page 7-1
	100	1	VI			
	1000	2.5	0			
Post and Beam Shores at Mid-span	40	0.5	VI+	Page 6- 20B	Page 8-2, 8-3	Page 7-2
	100	1	VI			
	1000	2.5	0			



TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 10 FT TO 25 FT.

SLAB 5 IN. TO 8 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 40 TO 60 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	+

CONCRETE CONSTRUCTION–Floors

ONE-WAY SLAB – Light Design

AS BUILT

Addition - 5/81

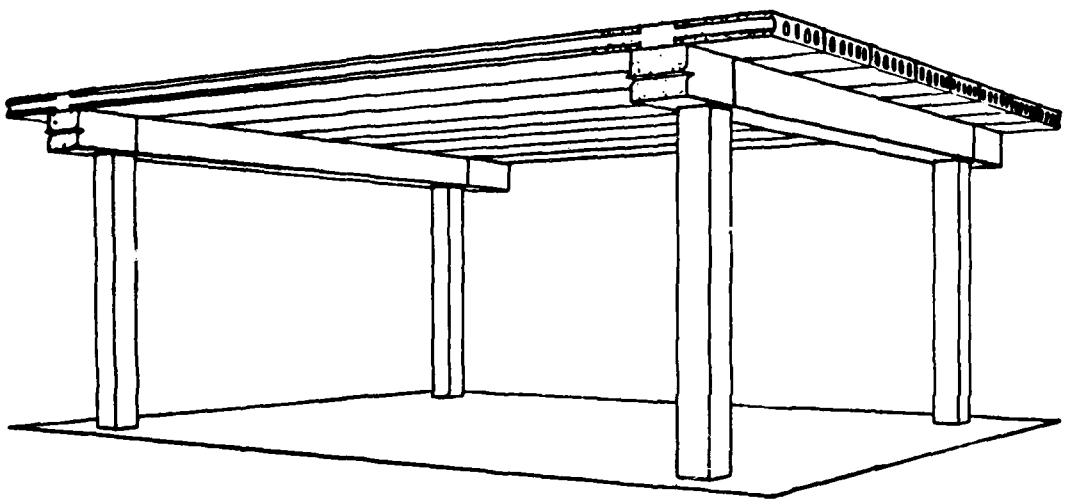
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

DOUBLE TEES - MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD- 80 to125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	0.5	VI+	Page 6-14	Page 8-1	Page 7-1
	100	1	VI			
	1000	2.5	0			
Post and Beam Shores at Mid-span	40	0.5	VI+	Page 6-15	Page 8-2, 8-3	Page 7-2
	100	1	VI			
	1000	2.5	0			



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 16 FT TO 30 FT.

SLAB 6 IN. TO 10 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 80 TO 125 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	0

CONCRETE CONSTRUCTION–Floors

HOLLOW–CORE – Medium Design

AS BUILT

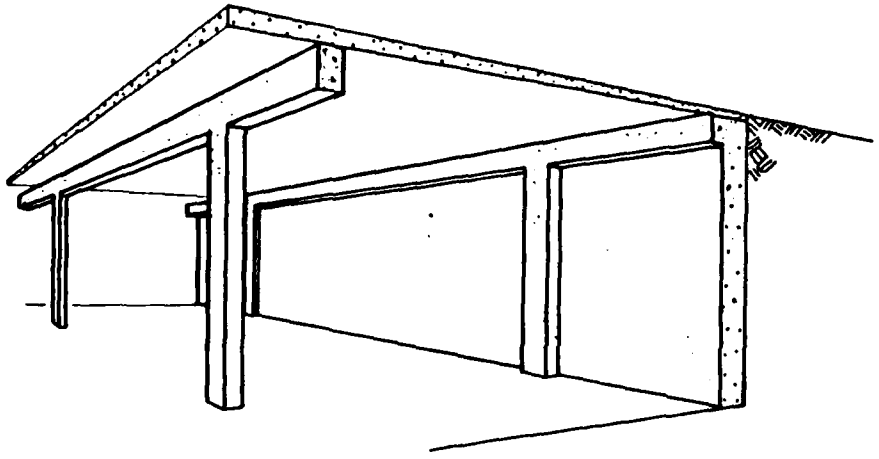
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

ONE-WAY SLAB - Medium Design

SUPERIMPOSED DESIGN LOAD- 80 to125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	0.5	VI+	6-20A	Page 8-1	Page 7-1
	100	1	VI+			
	1000	2.5	0			
Post and Beam Shores at Mid-span	40	0.5	VI+	6-20B	Page 8-2, 8-3	Page 7-2
	100	1	VI+			
	1000	2.5	0			



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 12 FT TO 30 FT.

SLAB 8 IN. TO 10 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 80 TO 125 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	N	VI
100	0.5	0
1000	2.0	0

CONCRETE CONSTRUCTION–Floors

ONE-WAY SLAB – Medium Design

AS BUILT

Addition - 5/81

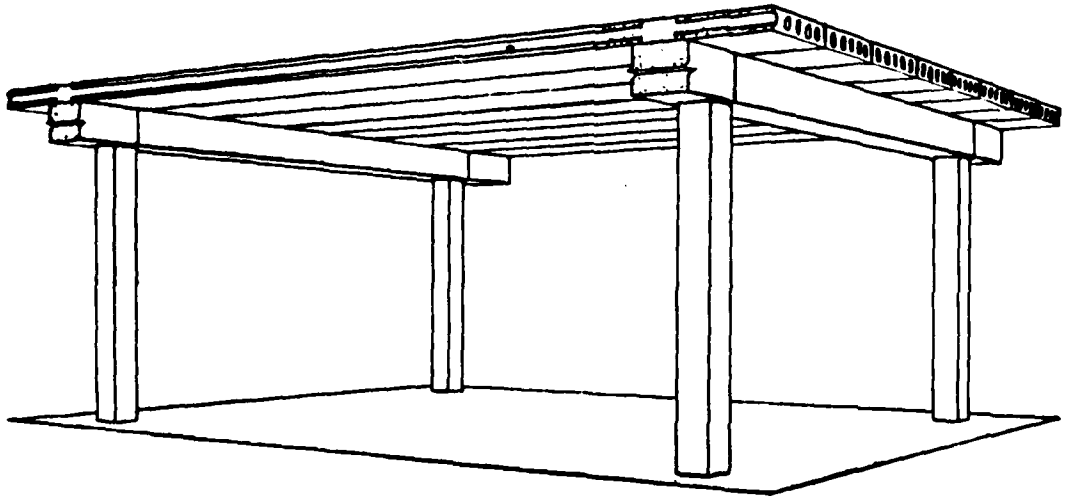
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

DOUBLE TEES - HEAVY DESIGN

SUPERIMPOSED DESIGN LOAD-150 to 250 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
None Required	40	0.5	VI+	DOES NOT REQUIRE UPGRADING		
	100	1	VI+			
	1000	2.5	VI			



TYPICALLY FOUND IN HEAVY MANUFACTURING BUILDINGS AND STORAGE WAREHOUSES.

SPANS NORMALLY 18 FT TO 28 FT.

SLAB 8 IN. TO 10 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 150 TO 250 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	VI$^+$
100	1	VI$^+$
1000	2.5	VI

CONCRETE CONSTRUCTION–Floors

HOLLOW-CORE – Heavy Design

AS BUILT

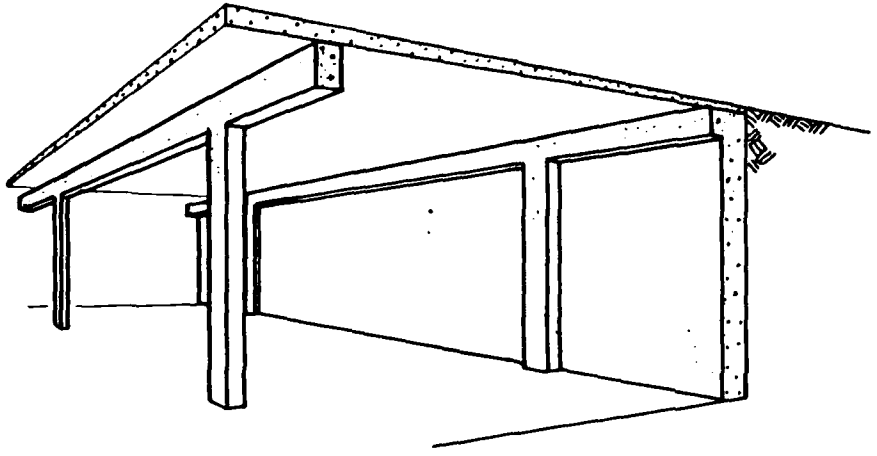
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

ONE-WAY SLAB - HEAVY DESIGN

SUPERIMPOSED DESIGN LOAD-150 to 250 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
None Required	40	0.5	VI+	DOES NOT REQUIRE UPGRADING		
	100	1	VI+			
	1000	2.5	VI			



TYPICALLY FOUND IN HEAVY MANUFACTURING BUILDINGS AND STORAGE WAREHOUSES.

SPANS NORMALLY 16 FT TO 30 FT.

SLAB 8 IN. TO 12 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 150 TO 250 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	N	VI^+
100	0.5	VI^+
1000	2.0	VI

CONCRETE CONSTRUCTION–Floors

ONE-WAY SLAB – Heavy Design

AS BUILT

INDEX

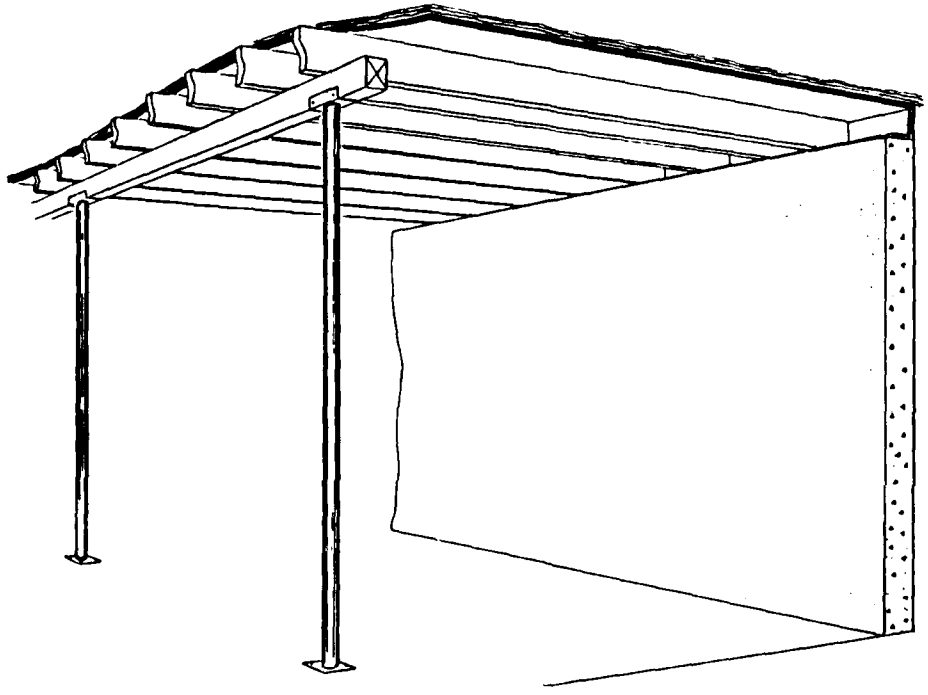
Revised - 5/81

WOOD CONSTRUCTION - ROOFS

SURVIVAL RATING VI

TIMBER JOIST

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Two rows of Wood Stud Walls, one each at 1/3 span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-23	Page 8-1	Page 7-1
Two rows of Post and Beam Shores, one each at 1/3 span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-24	Page 8-2, 8-3	Page 7-2



SPANS NORMALLY 6 FT. TO 24 FT., DEPTH OF JOIST 6 IN. TO 12 IN.

SUPPORTED BEAM CAN BE EITHER STEEL OR WOOD, AND SUPPORT POSTS WOOD OR STEEL PIPE.

DECK TOPPED WITH PLYWOOD, INSULATION, AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	†
100	-	-
1000	-	-

WOOD CONSTRUCTION–Roofs

TIMBER JOIST

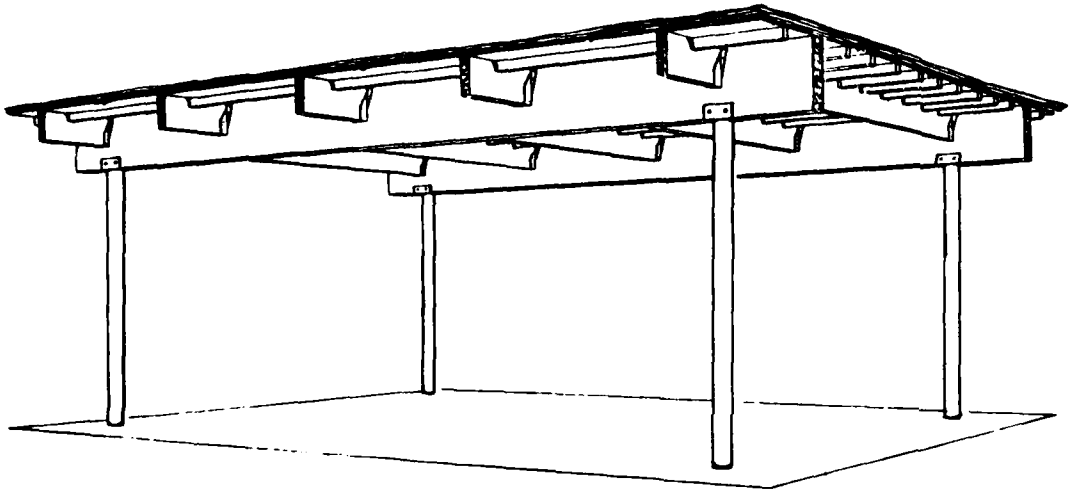
AS BUILT

WOOD CONSTRUCTION - ROOFS

GLULAM

SURVIVAL RATING VI

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Two rows of Wood Stud Walls, one each at 1/3 span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-25	Page 8-1	Page 7-1
Two rows of Post and Beam Shores, one each at 1/3 span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-26	Page 8-2, 8-3	Page 7-2



SPANS NORMALLY 6 FT. TO 24 FT., DEPTH OF GLULAM JOIST 4 IN. TO 8 IN., SUPPORTED ON GLULAM BEAM, NORMALLY 8 IN. TO 16 IN. DEEP.

SUPPORT POSTS WOOD OR STEEL PIPE.

DECK TOPPED WITH PLYWOOD, INSULATION, AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	†
100	-	-
1000	-	-

WOOD CONSTRUCTION–Roofs

GLULAM

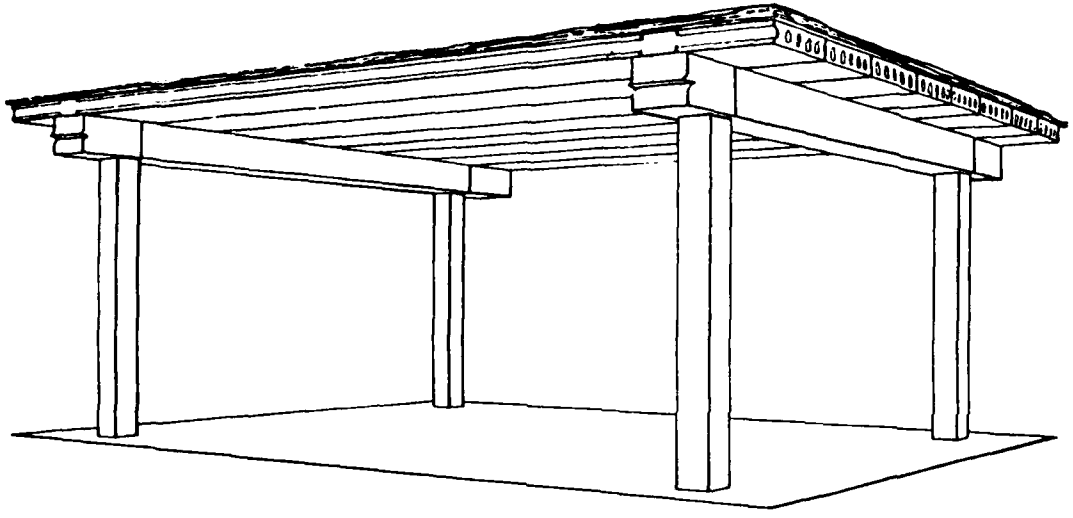
AS BUILT

STEEL - LIGHT CONSTRUCTION - ROOFS

SURVIVAL RATING VI

OPEN-WEB JOIST W/TIMBER DECK, INSULATION

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Two rows of Wood Stud Walls, one each at 1/3 span	40 100 1000	1 1.5 3	0 0 †	Page 6-27	Page 8-1	Page 7-1
Two rows of Post and Beam Shores, one each at 1/3 span	40 100 1000	1 1.5 3	0 0 †	Page 6-28	Page 8-2, 8-3	Page 7-2



SPANS NORMALLY 15 FT TO 40 FT.

SLAB 4 IN. TO 10 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DECK TOPPED WITH INSULATION AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	†
1000	-	-

CONCRETE CONSTRUCTION–Roofs
HOLLOW–CORE

AS BUILT

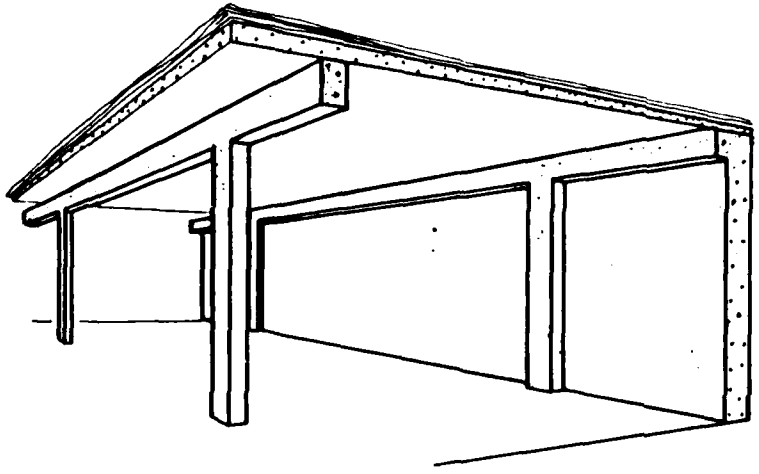
CONCRETE CONSTRUCTION - ROOFS

SURVIVAL RATING VI

ONE-WAY SLAB

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	0.5	VI+	Page 6-40	Page 8-1	Page 7-1
	100	1	VI			
	1000	2.5	0			
Post and Beam Shores at Mid-span	40	0.5	VI+	Page 6-41	Page 8-2, 8-3	Page 7-2
	100	1	VI			
	1000	2.5	0			

Addition - 5/81



SPANS NORMALLY 15 FT TO 30 FT.

SLAB 6 IN. TO 10 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DECK TOPPED WITH INSULATION AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	-

CONCRETE CONSTRUCTION–Roofs

ONE-WAY SLAB

AS BUILT

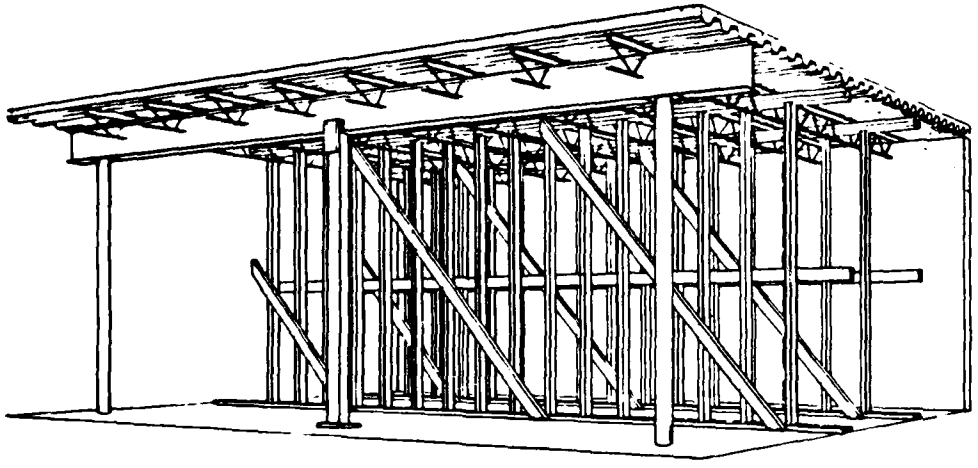
Addition - 5/81

INDEX

Revised - 5/81

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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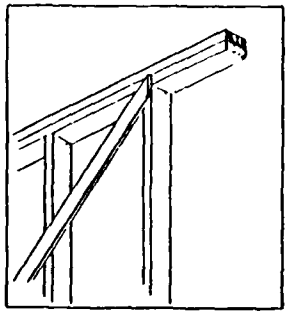
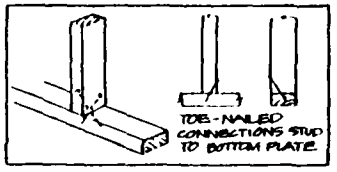
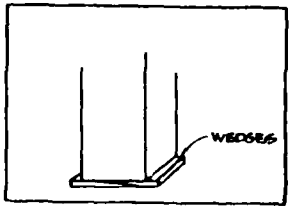
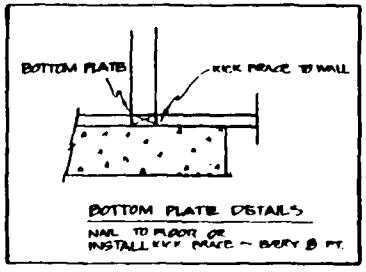


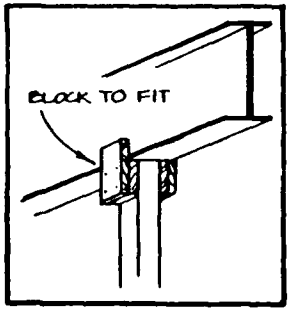
NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	TOE NAIL
1 x b	8d, 6d
2 x b	8d, 10d, 12d
3 x b	10d, 12d, 16d
4 x b	40d, 50d, 60d

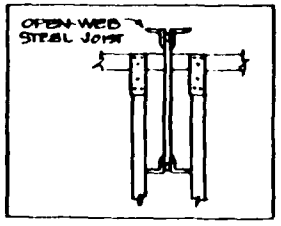
* when b = width of boards
when b = 6", use 2 nails
when b = 8", use 3 nails
when b = 8", use 4 nails

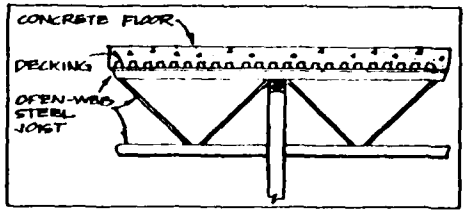












STEEL–LIGHT CONSTRUCTION–Floors

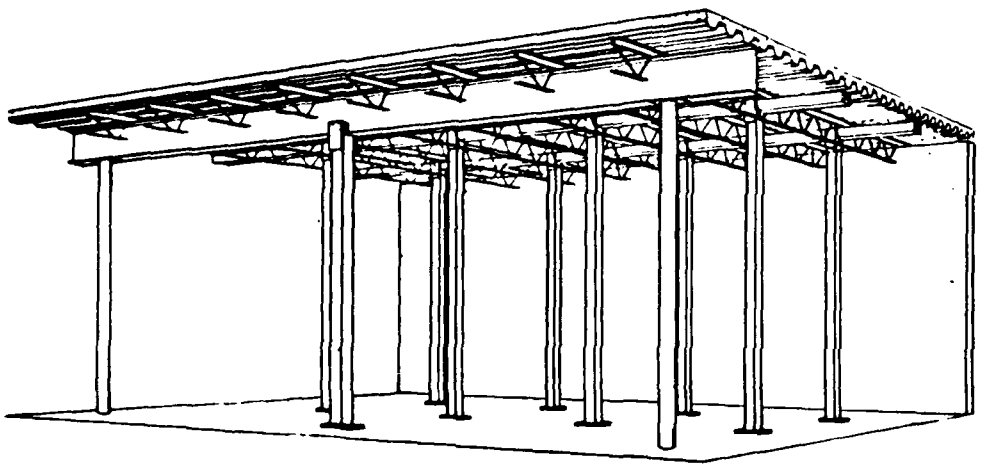
OPEN–WEB JOIST

stud wall upgrading

Revised - 3/81

RESOURCE LIST

Required	Quantity	Available
1. Timber (Posts)		
2. Timber (Beams)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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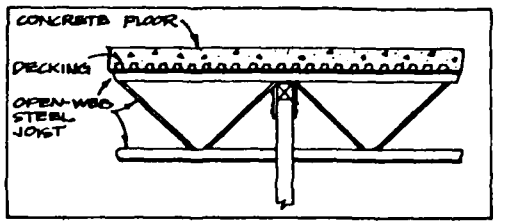
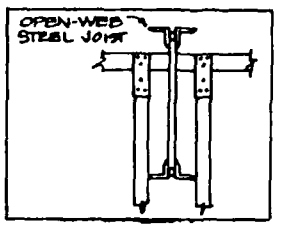
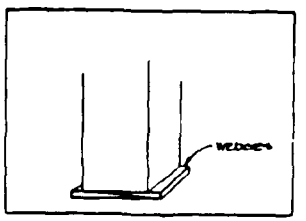
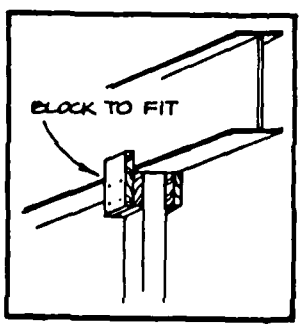


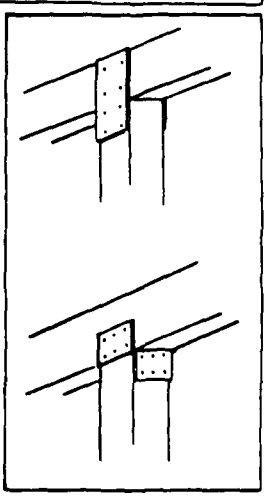






NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x w	6d, 8d
2 x w	8d, 10d, 12d
3 x w	16d, 20d, 30d
4 x w	40d, 50d, 60d

where w = width of boards
when w = 3 in, use 2 nails
when w = 4 in, use 3 nails
when w = 6 in, use 4 nails



STEEL–LIGHT CONSTRUCTION–Floors

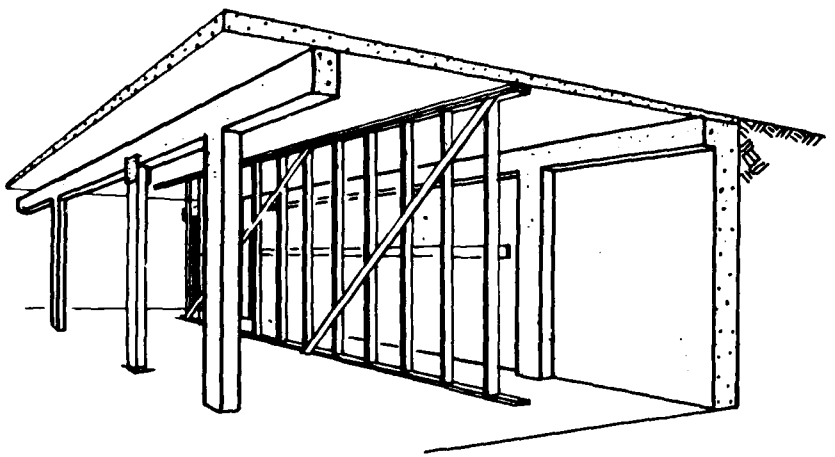
OPEN–WEB JOIST

Revised - 5/81

post & beam upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber		
2. Cable or Rods		
3. Connections		
4. Nails		
5. Hammer		
6. Saw		
7. Wedges		
8. Tape measure/yardstick, etc.		
9.		
10.		



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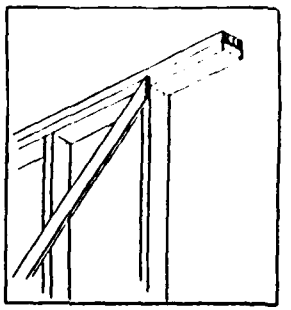
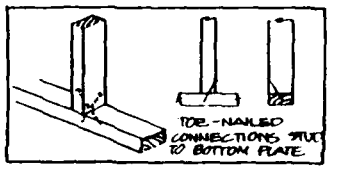
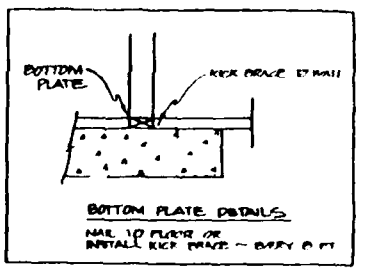
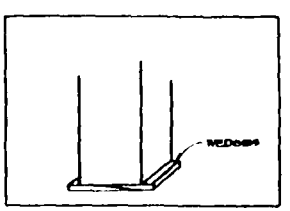






NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	16d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of boards
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails



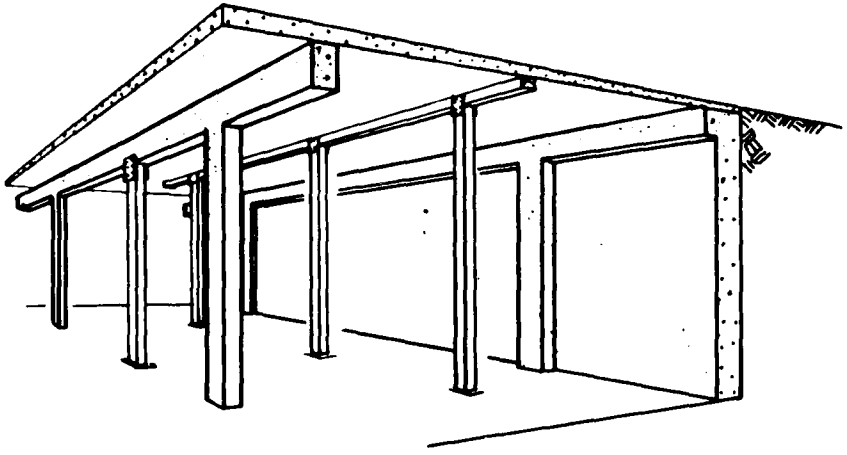
CONCRETE CONSTRUCTION–Floors

ONE-WAY SLAB

stud wall upgrading

RESOURCE LIST

	Required	Quantity	Available
1.	Timber (Posts)		
2.	Timber (Beams)		
3.	Nails		
4.	Hammer		
5.	Saw		
6.	Wedges		
7.	Tape measure/yardstick, etc.		
8.			
9.			
10.			



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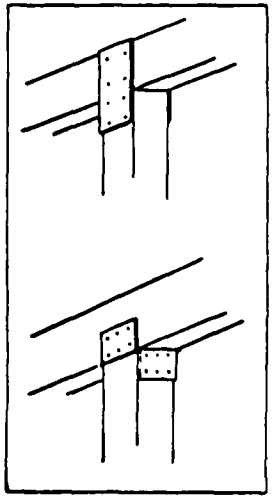
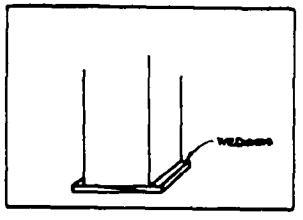


NAILING SCHEDULE	
BEAM SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	16d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of beams
when b = 8 in, use 2 nails
when b = 12 in, use 3 nails
when b = 16 in, use 4 nails



CONCRETE CONSTRUCTION–Floors

ONE-WAY SLAB

Addition - 5/81

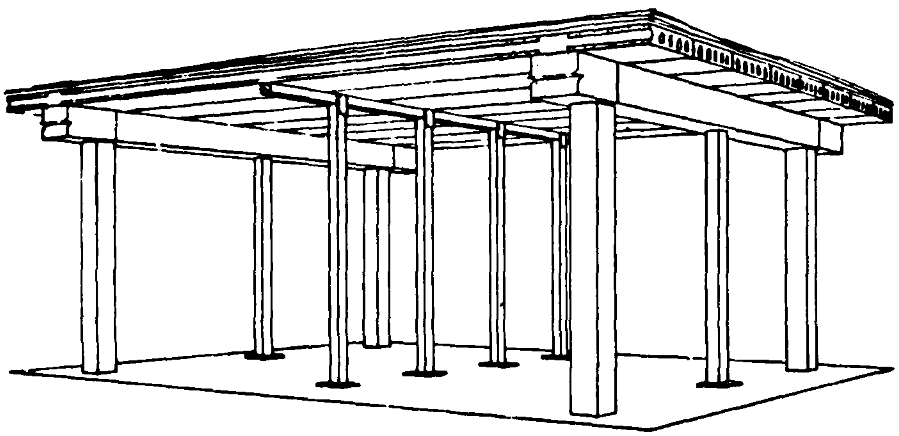
6-20B

post & beam upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		

Addition - 5/81



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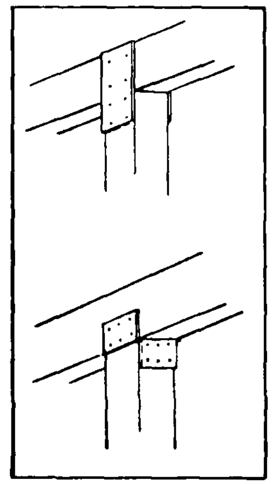
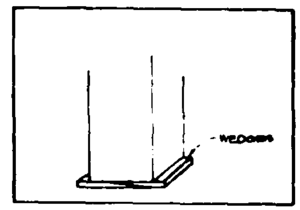




NAILING [illegible]	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x 6	6d, 8d
2 x 6	8d, 10d 12.1
3 x 6	16d [illegible] 30d
4 x 6	40d 50d, 60d
[illegible]	

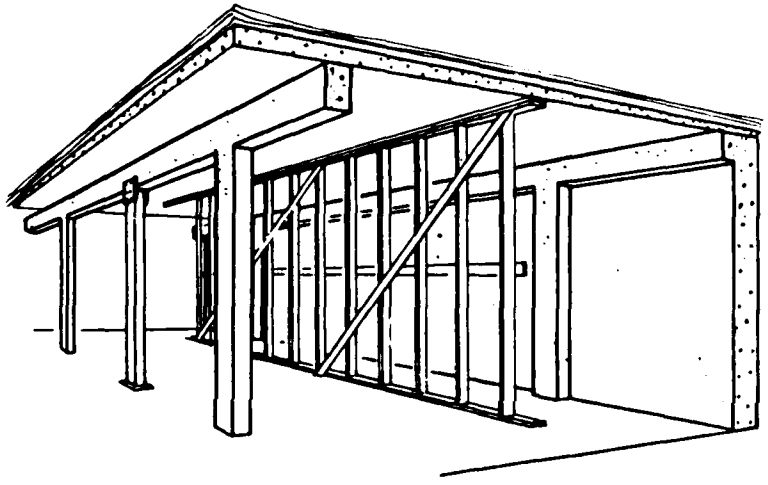
CONCRETE CONSTRUCTION–Roofs
HOLLOW-CORE

post & beam
upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		

Addition - 5/81



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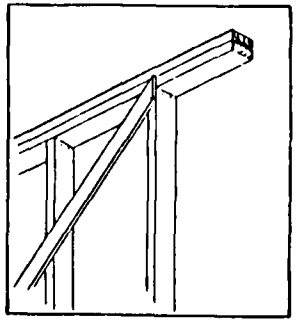
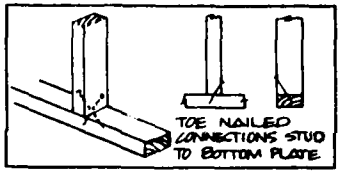
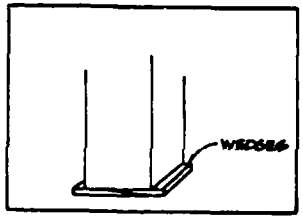
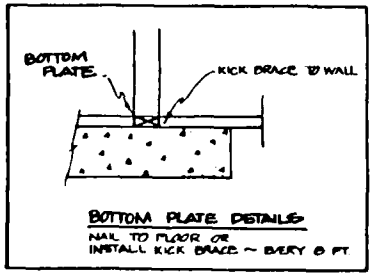


NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	10d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of boards
when b = 2", use 2 nails
when b = 4", use 3 nails
when b = 6", use 4 nails







CONCRETE CONSTRUCTION–Roofs

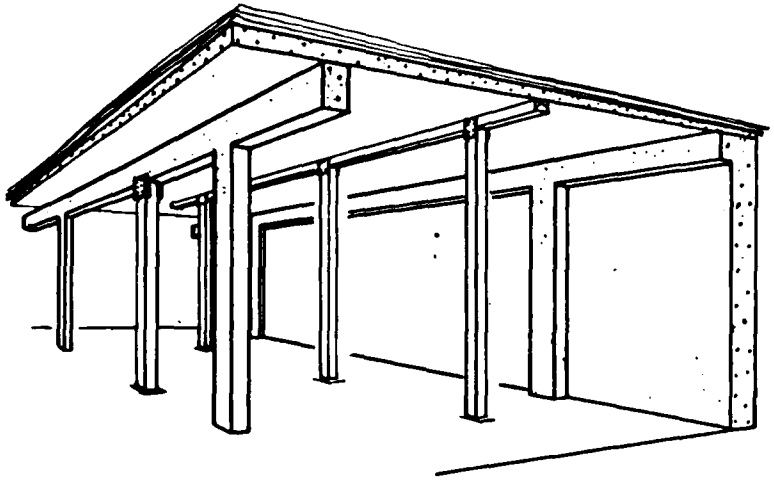
ONE-WAY SLAB

stud wall upgrading

Addition - 5/81

RESOURCE LIST

Required	Quantity	Available
1. Timber (Posts)		
2. Timber (Beams)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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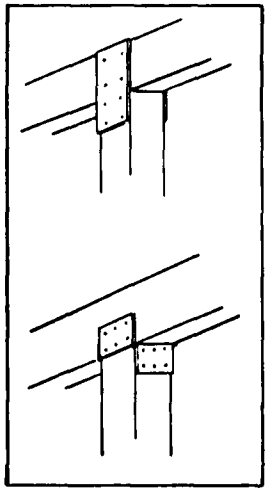
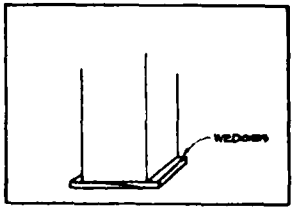




NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	16d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of boards
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails

CONCRETE CONSTRUCTION–Roofs

ONE-WAY SLAB

Addition - 5/81

post & beam upgrading

Appendix B
CLOSURES

Existing Shelters

It is probable that the majority of shelter spaces will need some form of closure. For example, a basement that has had the floor upgraded will probably have a stairway, windows, doors, ventilation ducts, access openings, etc. This section of the appendix describes several methods of closing off such typical openings in the walls or ceilings.

Openings can be bridged by use of a number of readily available materials, such as wood, steel, or concrete. Examples of wood that may be used are fence posts, cut-up power poles, railroad ties, solid doors, and standard beams and plank pieces. Examples of concrete are sidewalk slab sections and curb or gutter pieces; and of steel, plate would appear to be the most practical from a handling and placing standpoint, but steel rolled sections could also be used. Additional materials that may be used to close openings are bags or oil or paper drums filled with sand or earth, broken concrete, bricks, or concrete blocks. Table B-1 contains a list of some of the materials that might be considered for use in closing openings.

With the wood and concrete categories there are material differences, which affect their strength. Wood fence posts, power poles, or railroad ties could be badly splintered or rotted in the center. Wood beams and planks could also be badly splintered. Generally, "poor" timber is "utility" grade when new, as well as older material that now has loose knots, or holes where the knots have fallen out. Poor timber may also have many checks, shakes, and splits. These features are illustrated in Fig. B-1. The concrete sidewalk slab and curb sections usually contain minimum or no reinforcing. These sections should be inspected for any significant cracking, which could impair their intended use.

Table B-1

CLOSURE MATERIALS

Steel doors

Wood doors (solid)

Toilet doors and partitions

Tree trunks and limbs

Steel cover plates

Desk and table tops

Railroad ties

Plywood

Concrete slabs (sidewalks, etc.)

Wood, steel, or concrete fence posts

Telephone or power poles

* Filled sandbags

* Filled paper bags

* Filled paper boxes

* Filled plastic garbage cans

Brick or concrete block

* Filled oil or paper drums

Broken concrete

*filled with sand or earth

Expedient Shelters

Openings that require closure in expedient shelters may be quite different in size and shape from those encountered in existing structures. The closures used may the same as those employed for existing shelters, or their configuration may need to be different in order to accommodate various types of expediently constructed entry structures and openings.

This section of the appendix will illustrate several methods of fabricating expedient shelter closures.

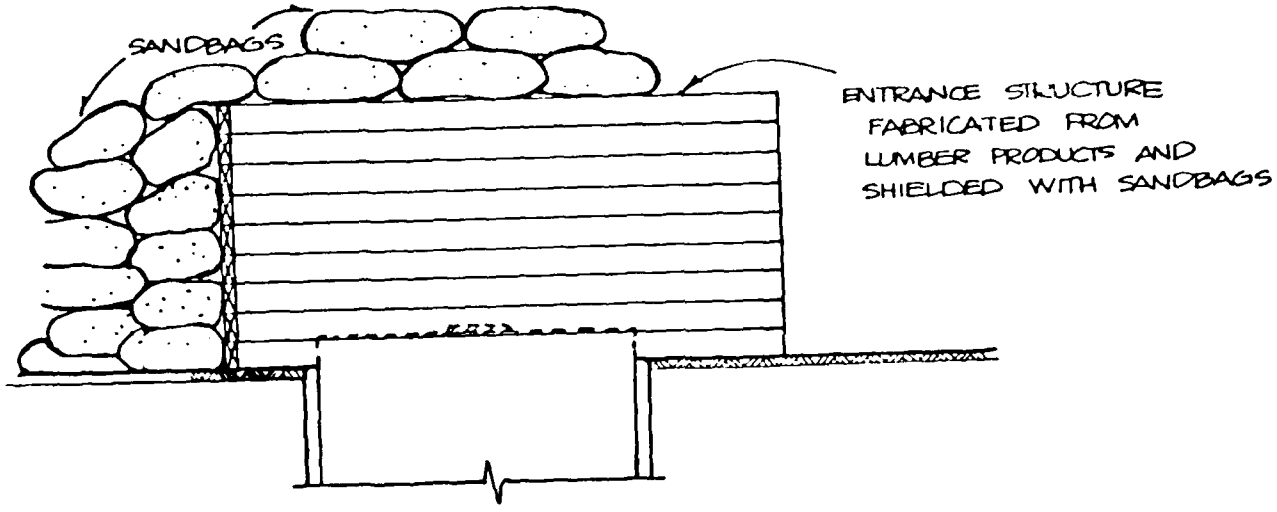


Fig. B-7. Radiation Protected Entrance Structure to Below Ground Shelters.

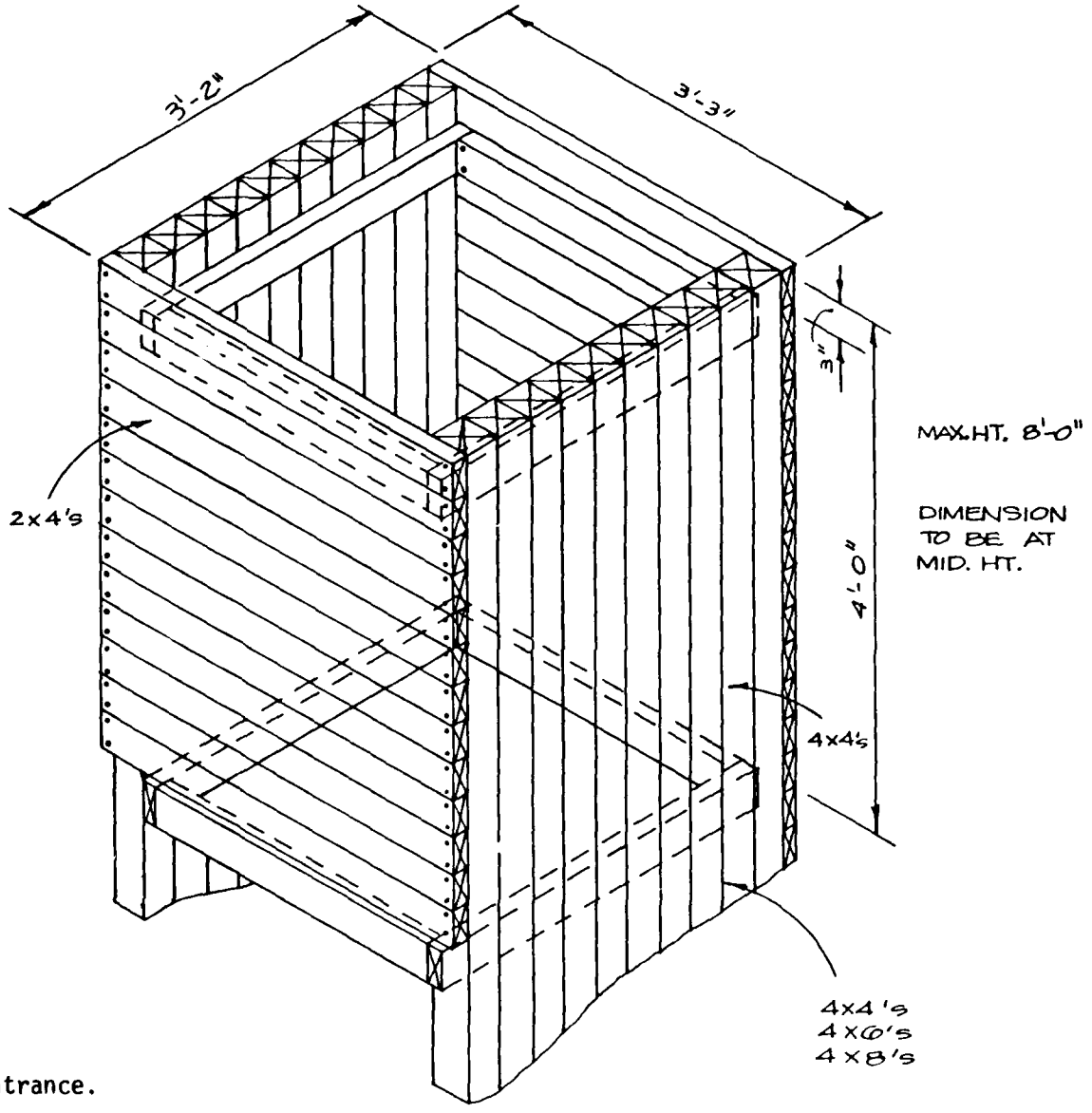


Fig. B-8. Shelter Entrance.

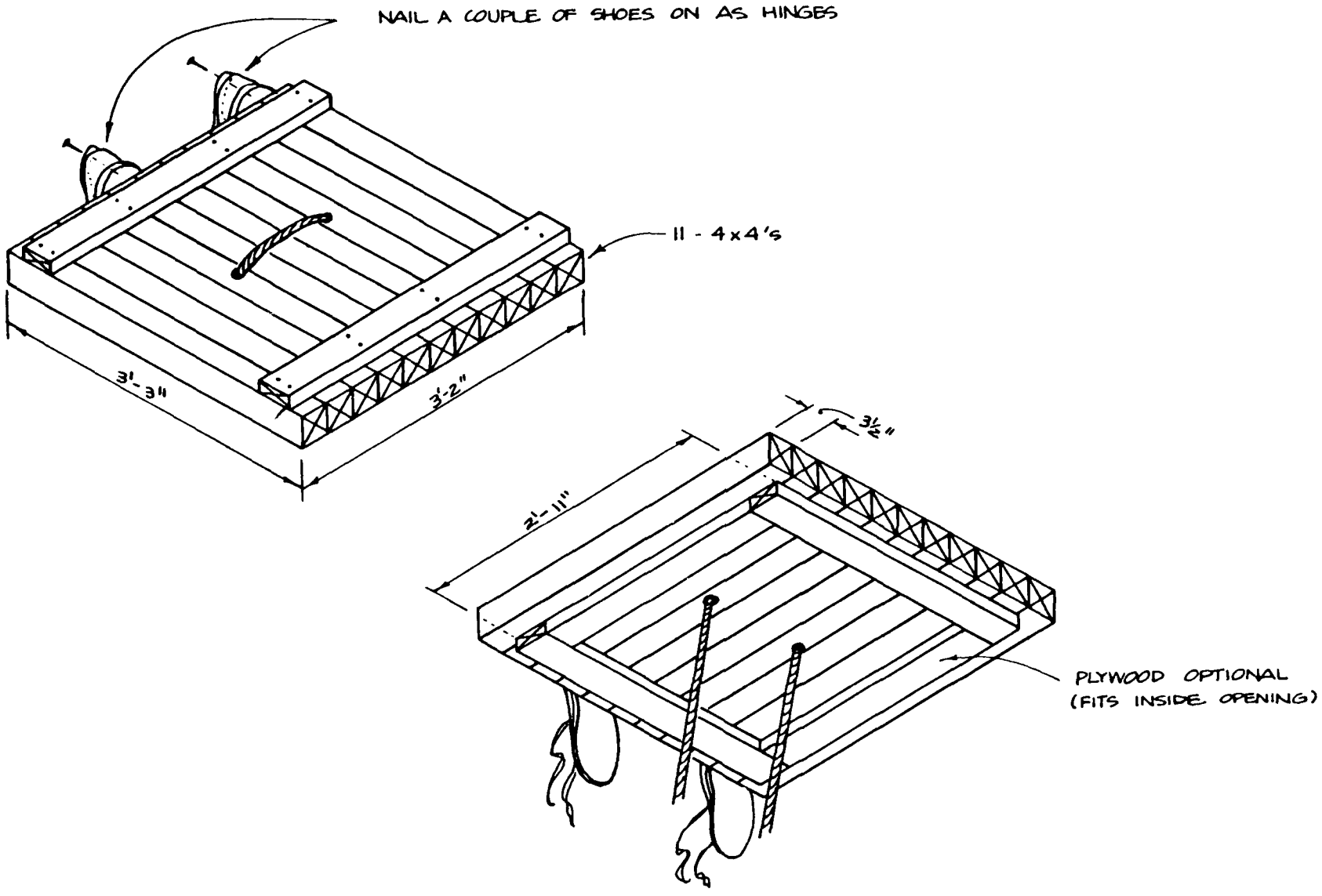


Fig. B-9. Shelter Door.

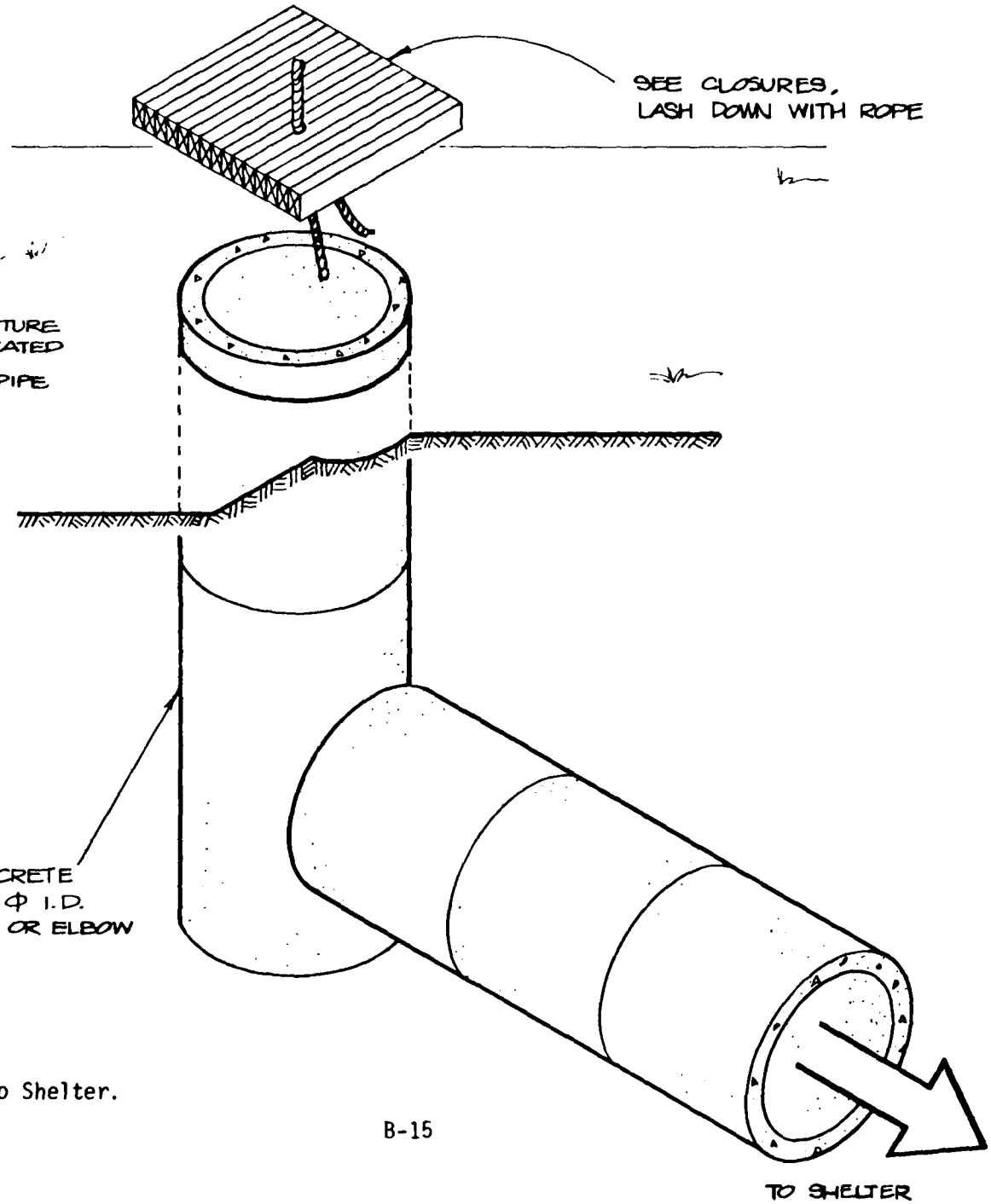


Fig. B-10. Entrance to Shelter.

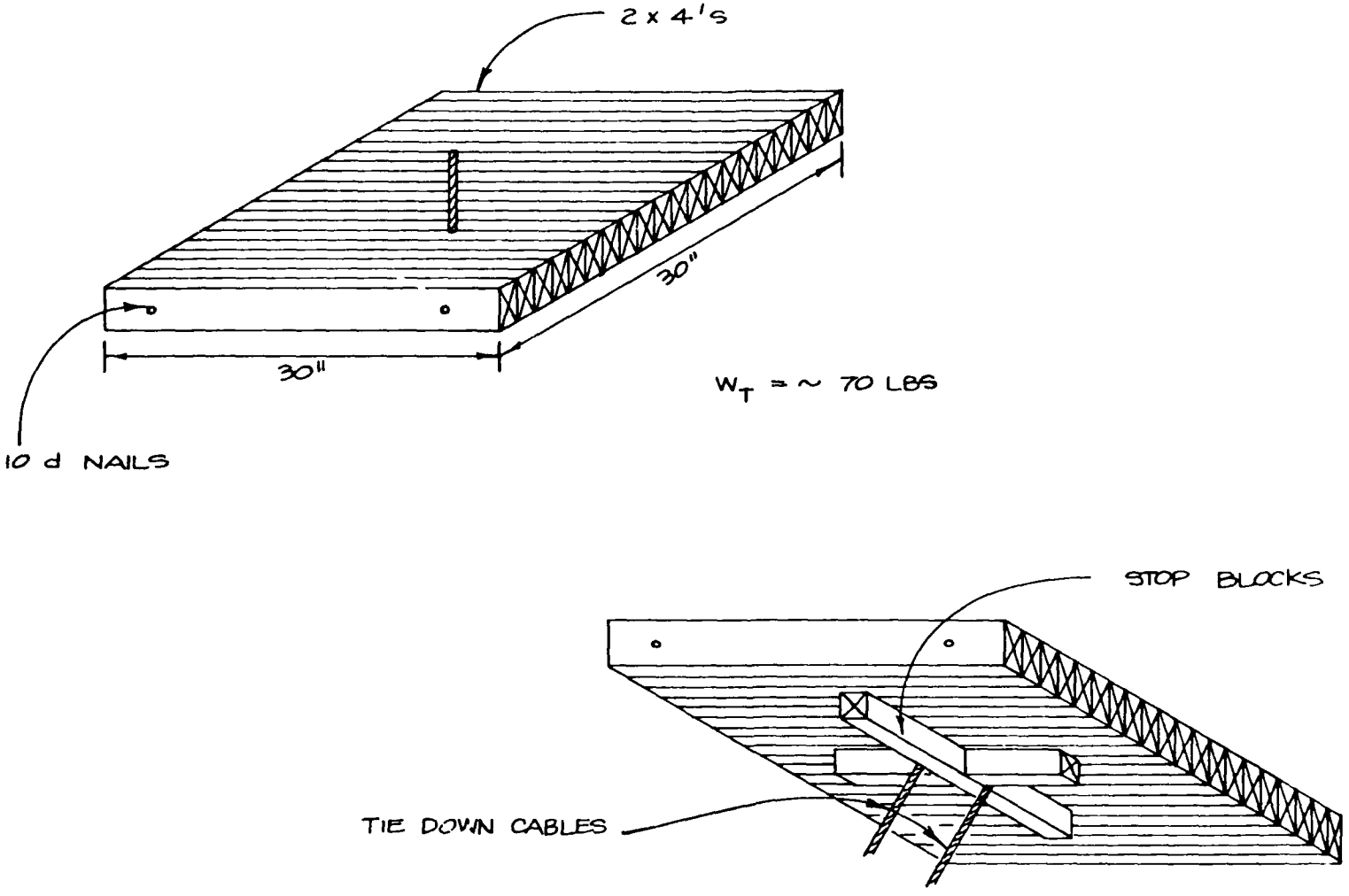


Fig. B-11. Expedient Manhole Closure, Host Area.

Addition - 5/81

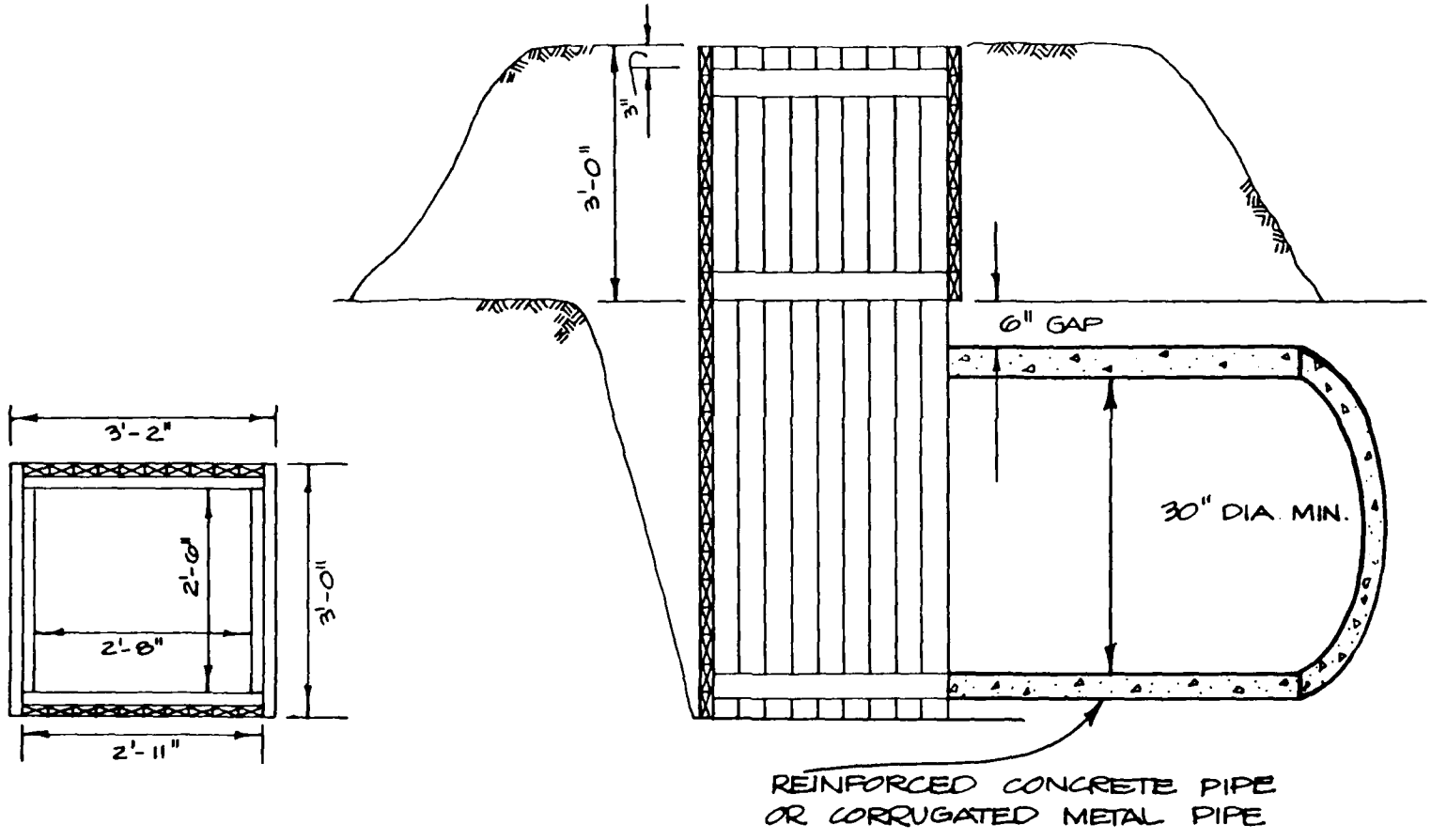


Fig. B-12. Typical Entryway to Buried Shelter With Culvert Shown.

APPENDIX D

EXPEDIENT SHELTER OPTIONS

Addition - 5/81

Appendix D
EXPEDIENT SHELTER OPTIONS

Owing to a limited number of existing structures in some of the designated Host Areas, it will be necessary to use expedient shelters. There is a wide variety of options that should be considered, including adapting facilities such as tanks, storm drains, utility vaults, or alternatively, obtaining a semi-portable structure that can be used as a buried shelter. Since many of these shelter options are large and require mechanical means to move and/or bury, or may be available only at or through local industry, a cooperative effort may be required with industrial plants, construction firms, or local civic authorities in order to render these options viable.

Table D-1 lists options that may be implemented without upgrading, and Table D-2 lists options that require some form of upgrading. Expedient shelter options discussed and data presented are as follows:

Two expedient shelter checklist summaries are provided at the end of this section for implementing expedient shelter options.

The shelter options discussed herein are only a few of the potential possibilities for Host Area shelters, and a pre-crisis survey should be conducted in order to determine the available options that would provide the best choice.

TABLE D-1: POTENTIAL HOST AREA SHELTERS

Shelter Option Description	Where to Locate, Whom to Contact
Cylindrical Tanks	Look in yellow pages of phone book for: (1) Tanks, Metal; (2) Tanks, Used; (3) Tanks, Fiberglass; (4) Tanks, Repairing; (5) Tank Lining and Coating.
Steel tanks	
Fiberglass tanks	
Surplus Railroad Cars	Obtain from railroad equipment and supply company. For example, the Purdy Company sells surplus rail cars and components.
Refrigerator	
Box cars	
Storm Drainage Facilities	City and county public workds departments and flood control districts. U.S. Geological Survey topographical maps and other special purpose maps (not road or street maps).
Manholes	
* Large pipe culverts	
* Box culverts	
Mine Shafts and Tunnels	U.S. Geological Survey geologic maps, State Division of Mines publications.
* Mine tunnels	
* Rail and highway tunnels	Road and rail maps.
Other Options	
Concrete utility vaults	Concrete products manufacturers in yellow pages.
Reinforced concrete pipe	Yellow pages under Concrete Pipe products, culverts, manufacturers, and pipe.
Concrete tanks	Yellow pages under Tanks — Concrete.

* Box culverts and tunnels require extensive closure systems to prevent longitudinal entry of blast effects.

TABLE D-2: POTENTIAL HOST AREA SHELTERS THAT REQUIRE UPGRADING

Shelter Option Description	Where to Locate, Whom to Contact	Upgrading Method
Surplus Railroad Cars		
Caboose Passenger	Obtain from railroad equipment and supply company. For example, the Purdy Company sells surplus rail cars and components.	Post and beam lateral span Plywood sheathing on exterior.
Other Options		
Surplus maritime shipping containers	Container manufacturing and repair companies; Containerization International Yearbook.	Post and beam lateral span
Trailer, truck van bodies	Yellow pages under truck bodies and truck equipment and parts.	Post and beam lateral span
Metal newspaper storage bins	Look in yellow pages under Waste Paper	Post and beam lateral span

EXPEDIENT SHELTER FACT SHEET

BURIED TANKS

Buried tanks provide ideal shelters and, depending on their size, can be used for Host Area shelters.

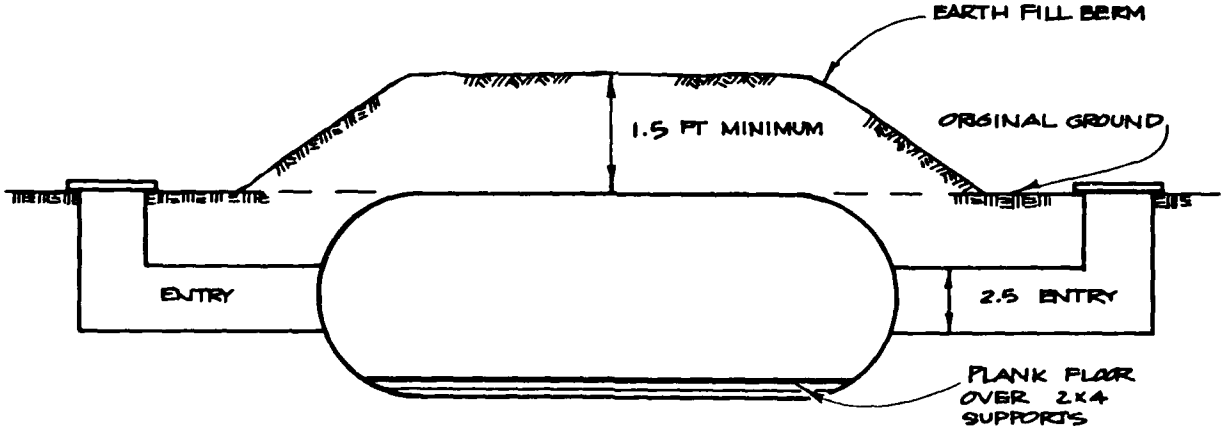
(1) Any newly manufactured, unused steel tank that is ordinarily used for underground storage.

(2) Any other type of non-pressure new tanks, such as fiberglass fuel tanks or septic tanks, intended for burial.

Limitations: (1) Do not use tanks that have been previously used for fuel storage, toxic chemicals, or other hazardous materials.

(2) Do not bury tanks in areas where high ground water is present, as the tanks may rise out of the ground because of fluid uplift.

TYPICAL INSTALLATION (ANY BURIED TANK)



Note: Entry can be fabricated using 30-inch diameter corrugated metal, concrete pipe, or wood framing. See Appendix B, Expedient Shelter Closures.

EXPEDIENT SHELTER FACT SHEET

RAILROAD CARS

Certain types of railroad cars can provide ideal shelter space without upgrading. Other types require minor upgrading. The railroad car options discussed are limited to those fabricated of structural steel components, as described, and would not ordinarily require upgrading:

Box cars and refrigerator cars (no upgrading)

Caboose and passenger car types require post and beam upgrading with closures on windows and other openings.

Limitations: (1) All cars require their undercarriages, couplers, and miscellaneous non-essential frame materials removed.

(2) Refrigerator cars have access hatches on the top. Thus, the cars could be buried upright or on their sides to provide access and ventilation.

(3) Box cars require access holes to be cut through the sides or ends of the cars.

(4) Caboose and passenger cars will require closures over existing window areas to prevent damage, and all interior seating should be removed.

(5) Upgrading schemes are best suited to post and beam type (see Figure D-1).

(6) Heavy cranes or other lifting equipment are required to bury and cover cars.

Advantages of Implementing Railcars:

(1) Railcar types suggested for expedient shelters are all constructed with steel frame exteriors. Steel or wood interiors vary with car type.

(2) Railcar bodies are readily available from car dismantler companies.

Details of railcars buried as expedient shelters are shown on the following pages.

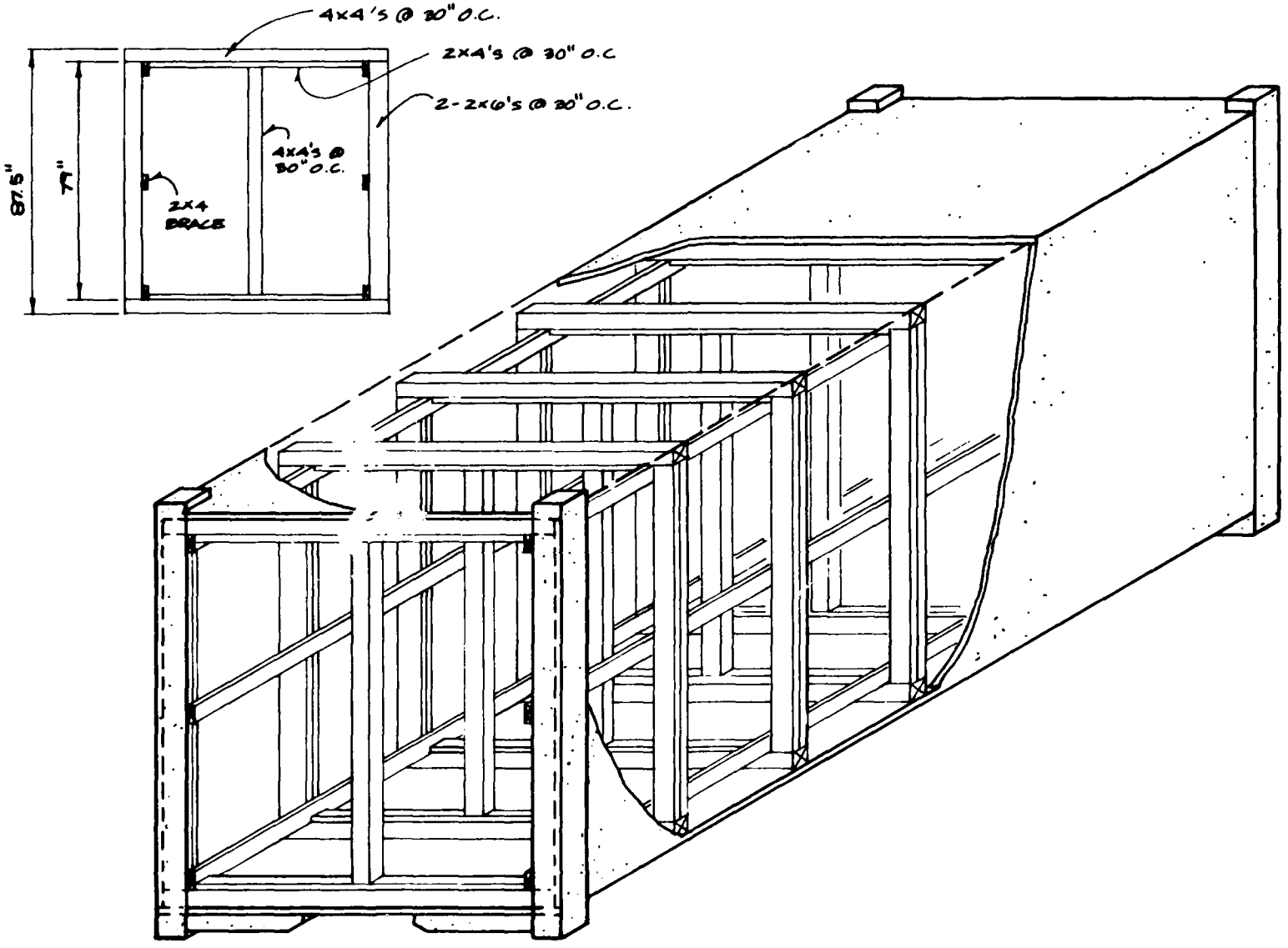
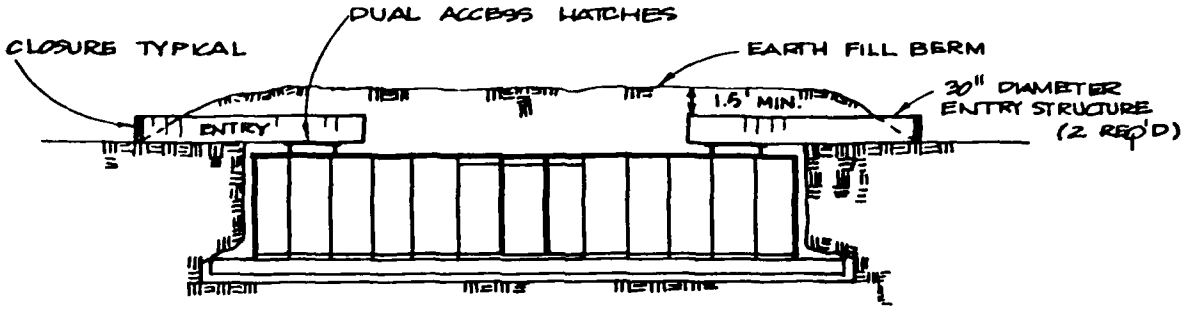


Fig. D-1. Post and Beam Shoring for Railcars, Maritime Shipping Containers, Truck Van Bodies.

TYPICAL BURIED REFRIGERATOR OR BOX CAR



Notes:

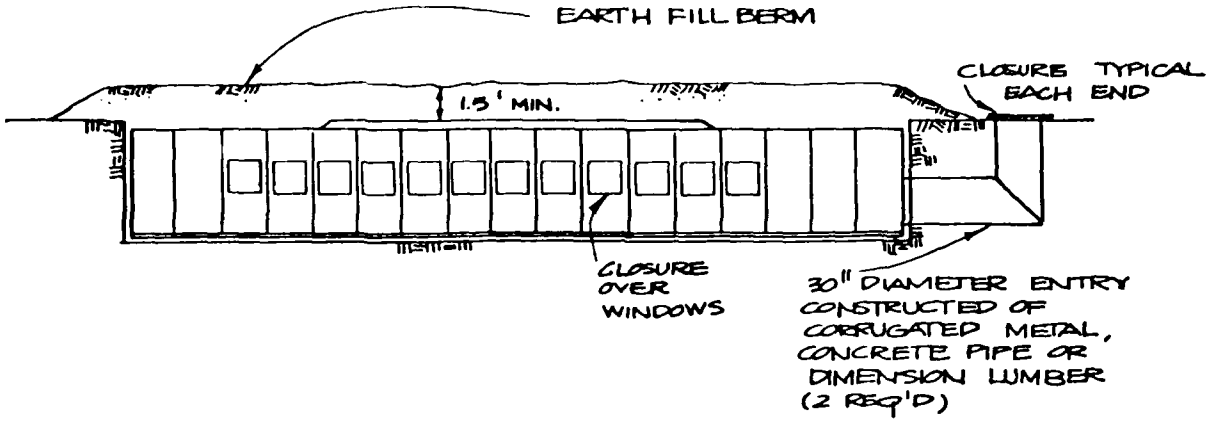
(1) Railcar undercarriage and miscellaneous frame components to be removed prior to burial.

(2) Access to hatches to be fabricated of 30-inch metal pipe or wood framed. Double entry to compartment hatches for ventilation is recommended. Alternate entry may be provided through side of car.

(3) Entrance closures are required for radiation protection.

(4) Cars to be cleaned prior to burial.

TYPICAL BURIED PASSENGER CAR OR CABOOSE



Notes:

(1) Railcar undercarriage and miscellaneous frame components are removed prior to burial.

(2) All windows must be provided with closures, although ventilation may be expedited by modifying window space.

(3) Access is proposed through existing doorways at end of car.

(4) Entrance closures are required for radiation protection.

(5) Car interior to be upgraded with post and beam shoring. (see Figure D-1).

EXPEDIENT SHELTER FACT SHEET

STORM DRAINAGE SYSTEMS

Major storm drainage facilities and their components can provide long-term shelter in Host Areas. Two components of a typical system are analyzed for shelter purposes:

- o Storm drain manholes.
- o Major conduits — 5 feet and larger.

Limitations: (1) Manholes should be a minimum of 4 feet in diameter and 6 feet deep.

(2) Manholes are often located in street traffic areas and therefore, may not be available at all locations. Manholes located in street medians, parking, or non-traffic areas may be more easily implemented.

(3) Storm drainage conduits may have considerable depth of flow or be located in areas subject to tidal action, thus eliminating their availability.

(4) Large closures are necessary at conduit ends to eliminate blast effects, and these closures probably cannot be completed in less than 72 hours (see Figure D-2).

(5) Blast effects must be eliminated at all open drain inlets by sandbagging.

(6) Depth of water flow may necessitate construction of false floor systems. (See sketch of box culvert type of floor system in Figure D-3.)

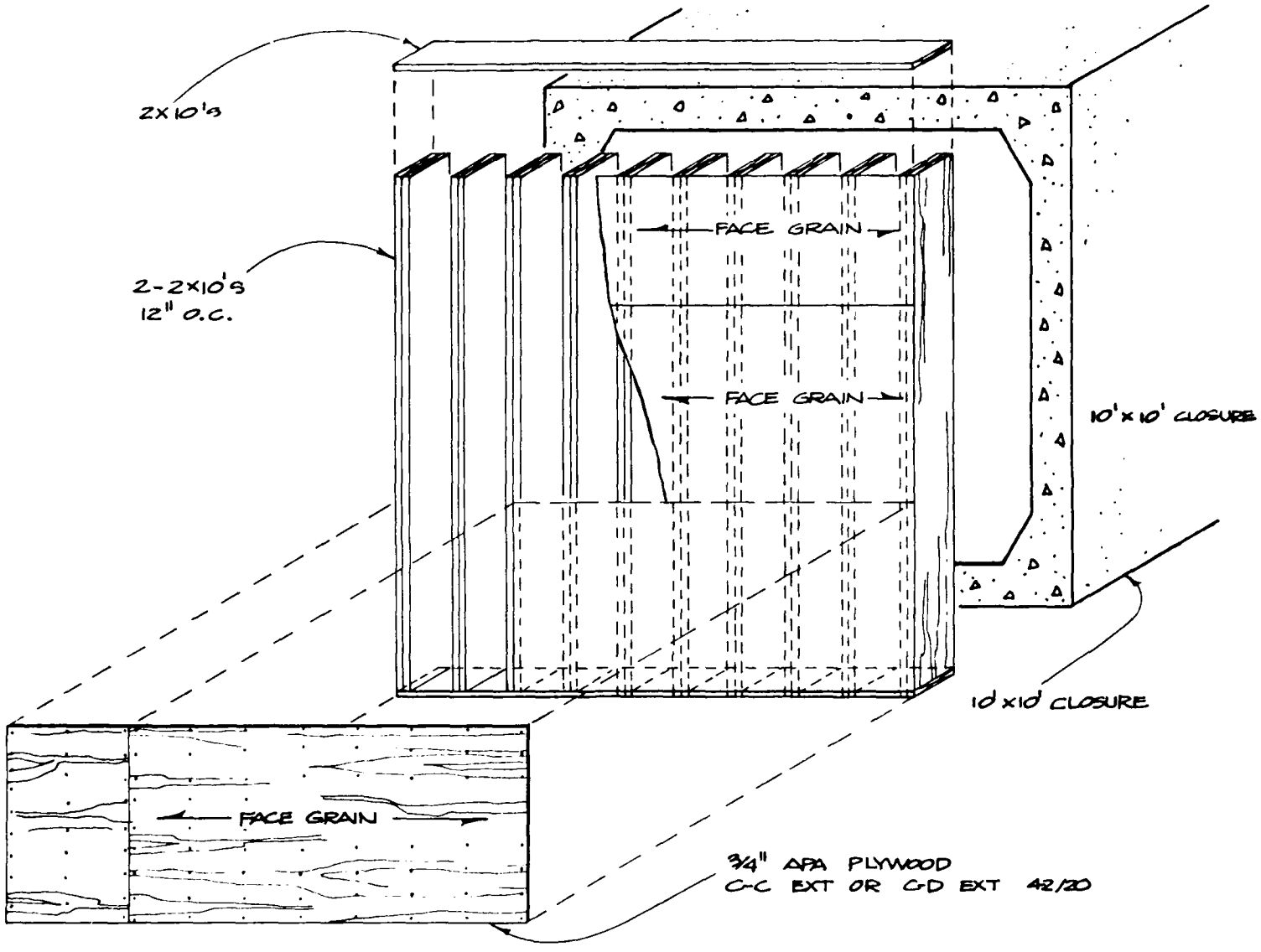


Fig. D-2. Typical Closure for a 10 ft by 10 ft Box Culvert For 2 psi.

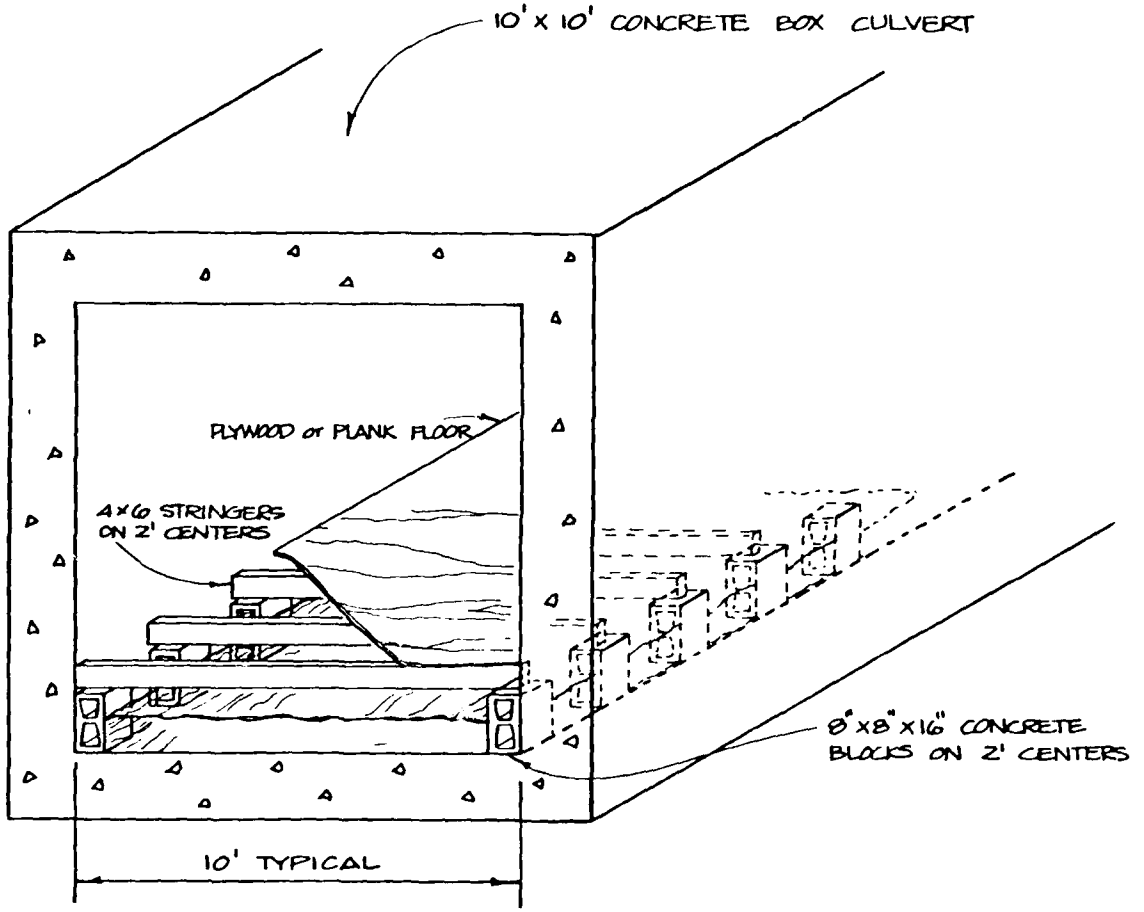


Fig. D-3. Box Culvert Host Area Shelter With Low-Flow False Floor.

Advantages of Using Storm Drain System Components as Expedient Shelters

Manholes:

(1) Storm drain manholes are numerous. On any major drainage system they are located from 500 to 1,000 feet apart.

(2) They require no upgrading and are easily adapted to use as one-man shelters, with addition of a temporary wood floor and modifications to manhole lid closures.

(3) Ventilation is not required, as ventilation naturally occurs through drain pipes at base of manhole.

(4) If storm drains are not available near the Host Area, manhole section components, as shown in Figure D-4, may be obtained from manufacturers, and one-man shelters can be buried at the Host Area site. For small industries with few employees, this may be a viable option.

Drainage Conduit Systems Greater Than 5 feet in Diameter:

(1) Radiation or fallout shielding is generally not necessary because of depth of burial.

(2) Ventilation equipment is not needed, as the systems have natural ventilation at all inlet locations. Fabrication of blast resistant closures with ventilation hatches must be implemented.

(3) Drain systems are large enough to provide shelter for more than one industry.

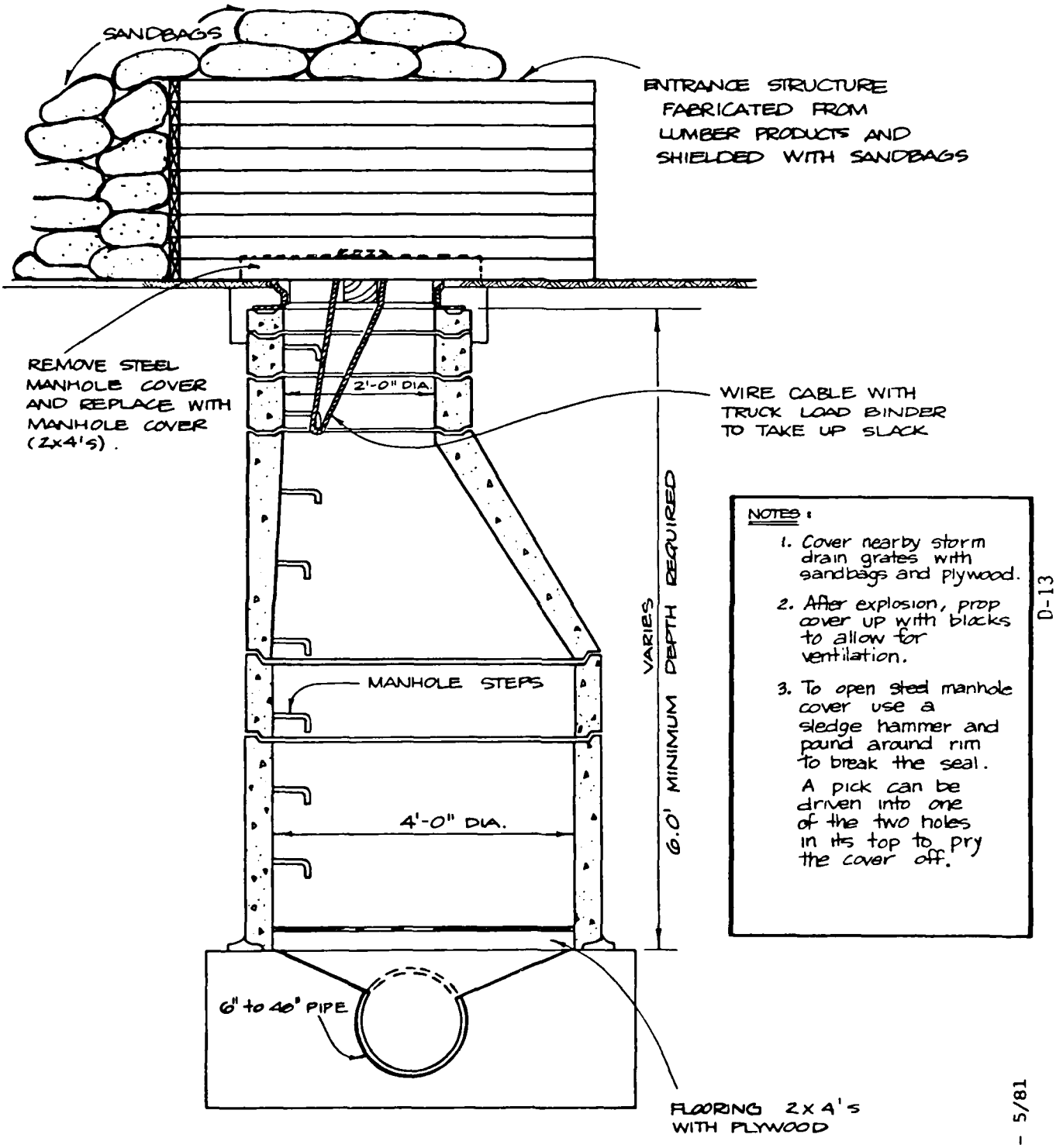


Fig. D-4. Host Area Shelter in Storm Manhole.

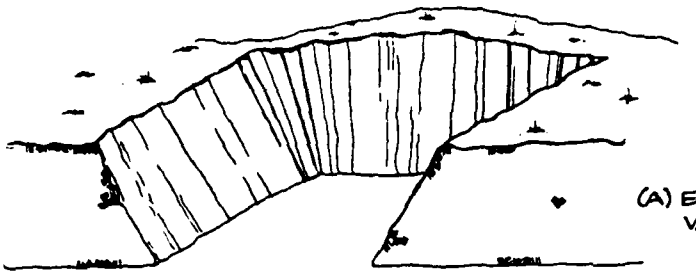
EXPEDIENT SHELTER FACT SHEET

CONCRETE UTILITY VAULTS

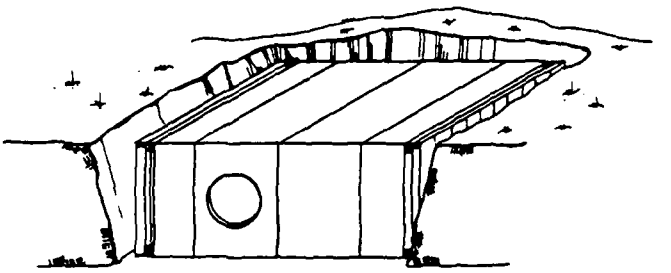
The adaptation of prefabricated underground utility vaults (the types used by telephone and electric utilities) for Host Area shelters is recommended as a valuable, practical, and easily implemented shelter option.

The implementation of precast utility vault components for a shelter has been previously tested, and placement of a six-man vault and entrance structure, including covering the vault with earth radiation protection, required less than 10 hours using three men and heavy equipment.

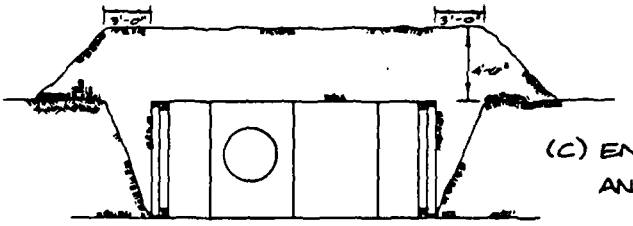
Figures D-5 and D-6 show the burial of a utility vault shelter and the various components needed to complete a shelter structure.



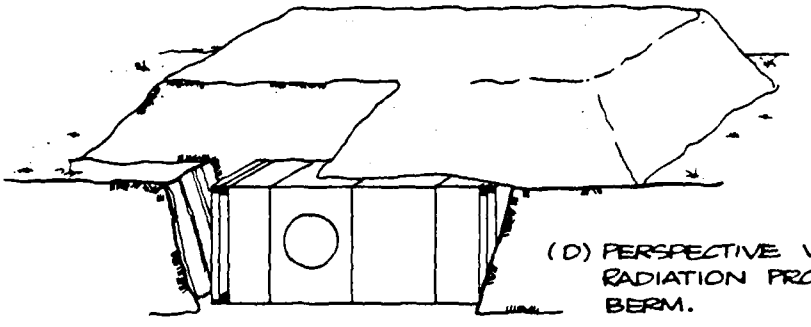
(A) EXCAVATION FOR UTILITY VAULT.



(B) VAULT IN PLACE PRIOR TO BACKFILLING.



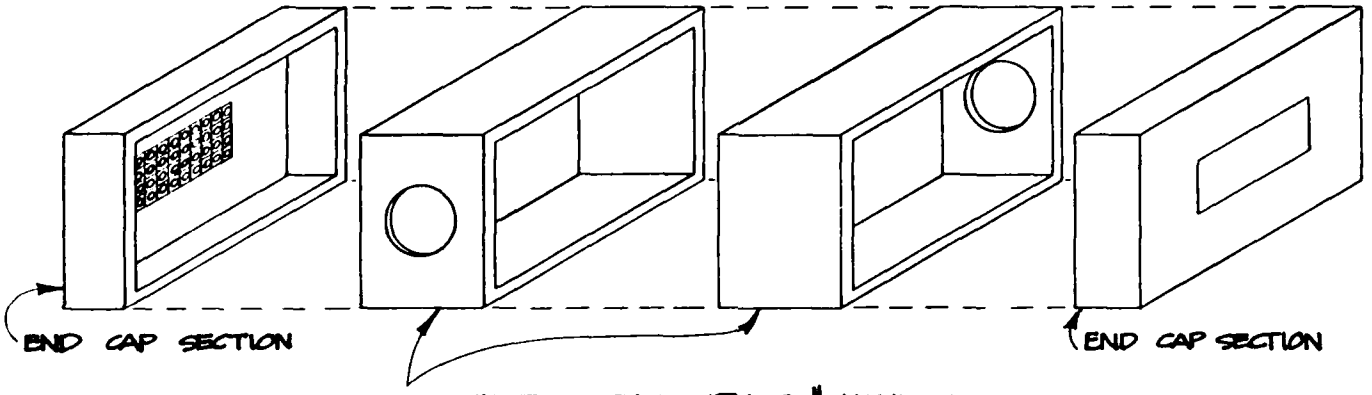
(C) END VIEW SHOWING BACKFILL AND RADIATION PROTECTION BERM.

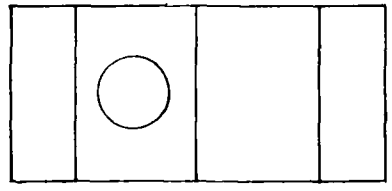


(D) PERSPECTIVE VIEW OF RADIATION PROTECTION BERM.

Fig. D-5. Utility Vault Shelter.

ASSEMBLY DRAWING





COMPOSITE ELEVATION SECTION

Fig. D-6. Utility Vault Shelter Components, Depicting Upgrading Methods to Provide 2 psi Overpressure Protection.

EXPEDIENT SHELTER FACT SHEET
SHIPPING CONTAINERS

Maritime shipping containers are an easily adapted option to shelter deficits in Host Areas. A wide range of container sizes, construction types, and design capabilities are available. The majority of container types are readily adaptable to Host Area shelter use.

Advantages of Using Maritime Shipping Containers for Shelter Purposes

- A wide variety of sizes are available; standard sizes are:

  8 ft x 8 ft x 20 ft
  8 ft x 8 ft x 40 ft
  8 ft x 8 ft 6 in. x 35 ft
  8 ft x 8 ft 6 in. x 40 ft

- Construction materials are steel, stainless steel, glass fiber reinforced plywood (FRP), and aluminum. The containers are generally designed for dry freight and some are insulated; however, refrigerator units amount to approximately 7% of the total number (Figure D-7).

- The maritime industry has standardized construction details, and certification is a prerequisite to approval for use. Component strengths are listed below. These strengths reflect only the component listed. Frame members are designed to be stacked fully loaded, nine containers high, which may provide additional resistance to loads.

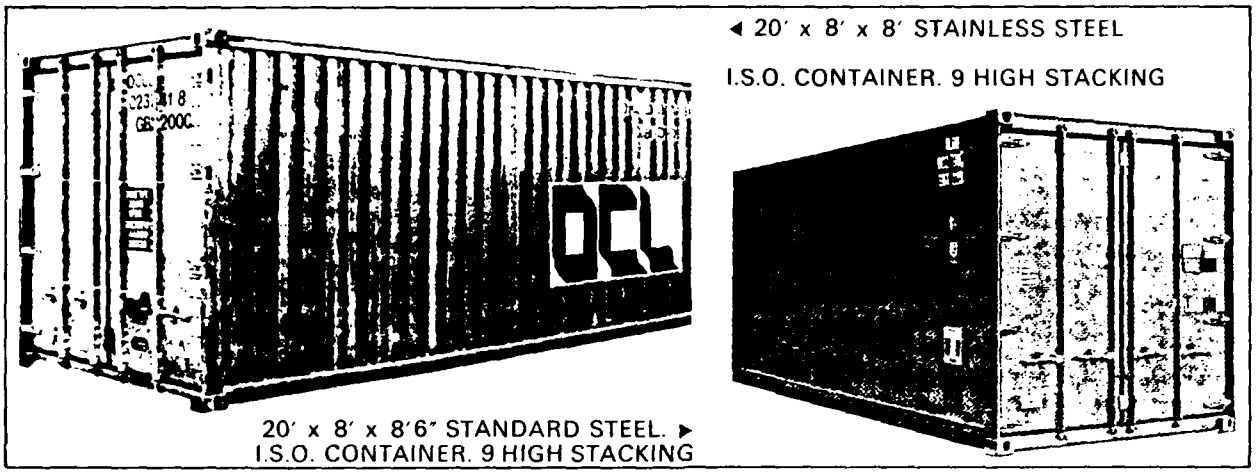
Container Component	Design Strength (psi)
Roof	0.5+
Floor	26 ±
End wall	1.7±
Side wall	0.9±

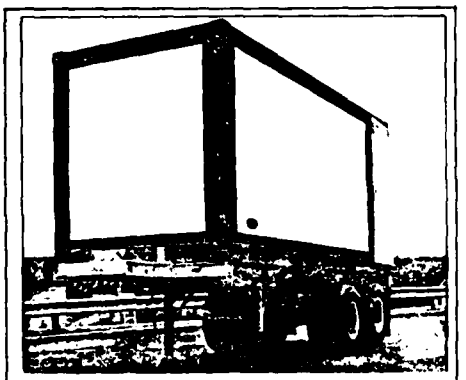
- o The majority of containers are designed to be waterproof and have a life of 7 years.
- o Upgrading to 2 psi overpressure and radiation protection of 2 feet or more of earth can be provided with post and beam shoring. After nuclear blast effects are no longer a threat, the intermediate post shores may be removed.
- o Containers are readily available from manufacturers, repair companies, and firms that deal exclusively in surplus containers.
- o They are designed to be adapted to a variety of cargo handling and transportation equipment. Empty 20-foot containers weigh approximately 4,300 lb; 40-foot containers, 7,500 lb. (Figure D-8).
- o Prior to the crises envisioned in a nuclear war, the containers may be used for secure locked storage of shelter resources and supplies.
- o They are easily transported to the site by truck and trailer.

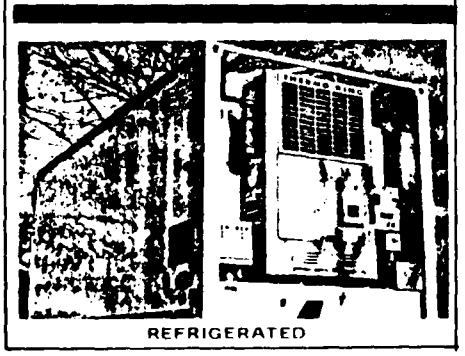
Limitations:

- o The containers are available at nearly every major port facility city, but not nationwide.
- o Demand for used containers is high, because of their storage capabilities and versatility.

Maritime shipping containers, when properly implemented, could be a valuable option to shelter deficits. The inherent structural strength of the floor systems indicates that containers may possibly survive blast pressures in excess of 20 psi if buried upside down with proper shoring. Full-scale field tests are recommended to determine ultimate capability.







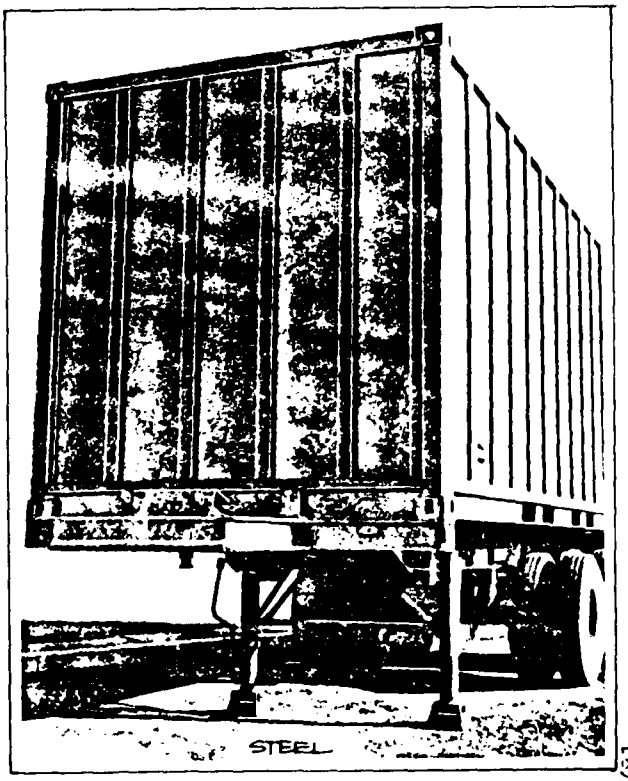


Fig. D-1. Typical Maritime Shipping Containers.

Typical Interior Details.

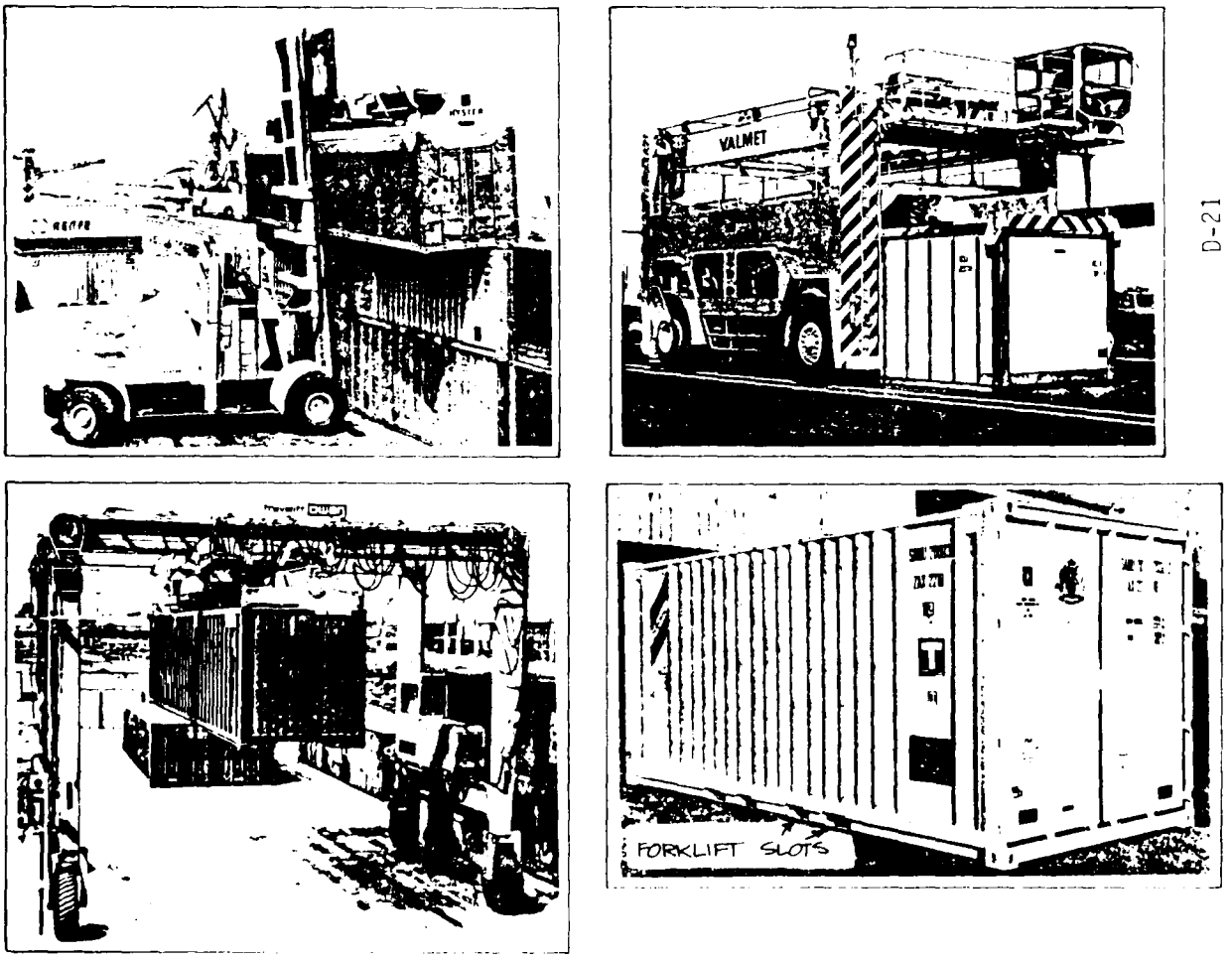


Fig. D-8. Typical Lifting Methods.

EXPEDIENT SHELTER FACT SHEET
TRUCK VAN BODIES

Another resource option for Host Area shelters are truck van bodies. A sketch showing a truck van body as a buried shelter is presented in Figure D-9.

Advantages of Using Truck Van Bodies for Host Area Shelter Purposes:

- o A wide variety of sizes are available.
- o Construction materials are steel, stainless steel, and aluminum.
- o They are waterproof.
- o Upgrading to 2 psi overpressure and radiation protection may be provided with post and beam construction (Figure D-1).
- o They are readily available throughout the United States.
- o They are integral with trailer frame and chassis, ready to be moved.
- o They are designed for a variety of uses.
- o They may be used for secure locked storage for shelter supplies and resources.

Limitations to Truck Van Bodies as Host Area Shelters

- o They are constructed integral with trailer frame and wheels, and thus reduce the inventory of available transportation resources in the crisis period.
- o Without the trailer floor, structural integrity is basically eliminated, and thus, they would require significant effort and resources to re-establish equivalent capability as a shelter option.
- o Demand for trailer van bodies is high, and they consequently would be a more costly alternative to other options.

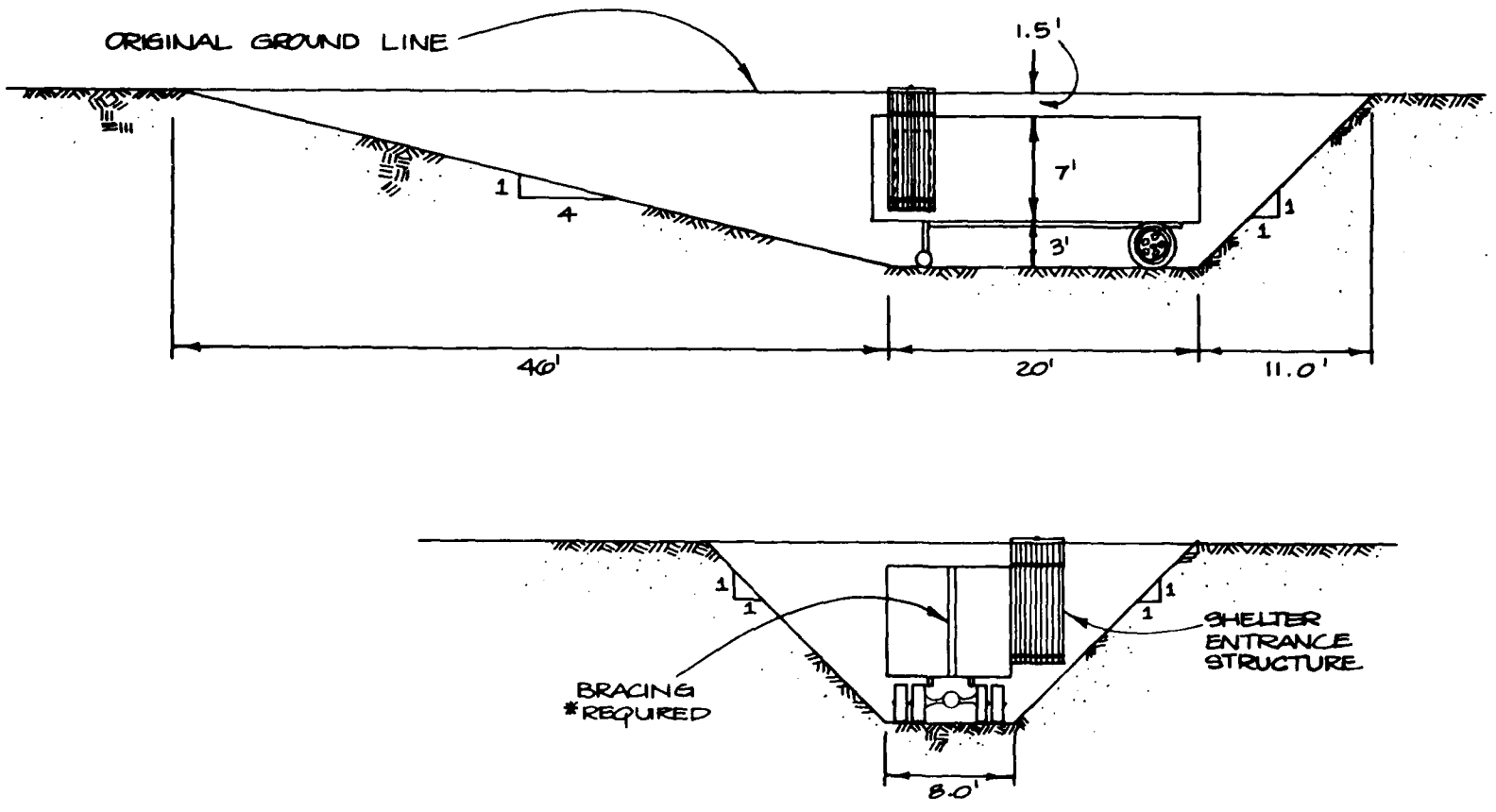


Fig. D-9. Buried Truck Trailer Van Host Area Shelter.

EXPEDIENT SHELTER FACT SHEET
OTHER OPTIONS

There are a number of other options to provide Host Area shelters. These options may not be the most desirable from a long stay-time criterion, but they do provide adequate radiation protection.

TRENCH SHELTERS

Figure D-10 describes a typical trench shelter. Its implementation requires only mechanical excavation equipment, sufficient planks or other resources for support of the mounded earth, and soil strata that will stand vertical to a depth of 6 feet, with no ground water at that excavated depth.

FABRICATED MANHOLES

Figure D-11 describes in some detail a shelter fabricated from readily available reinforced concrete and corrugated metal pipe. The construction of such a shelter requires only a backhoe for excavation and backfill. The expedient manhole cover should have an entrance structure similar to the one shown in Figure D-4, including sandbag radiation protection.

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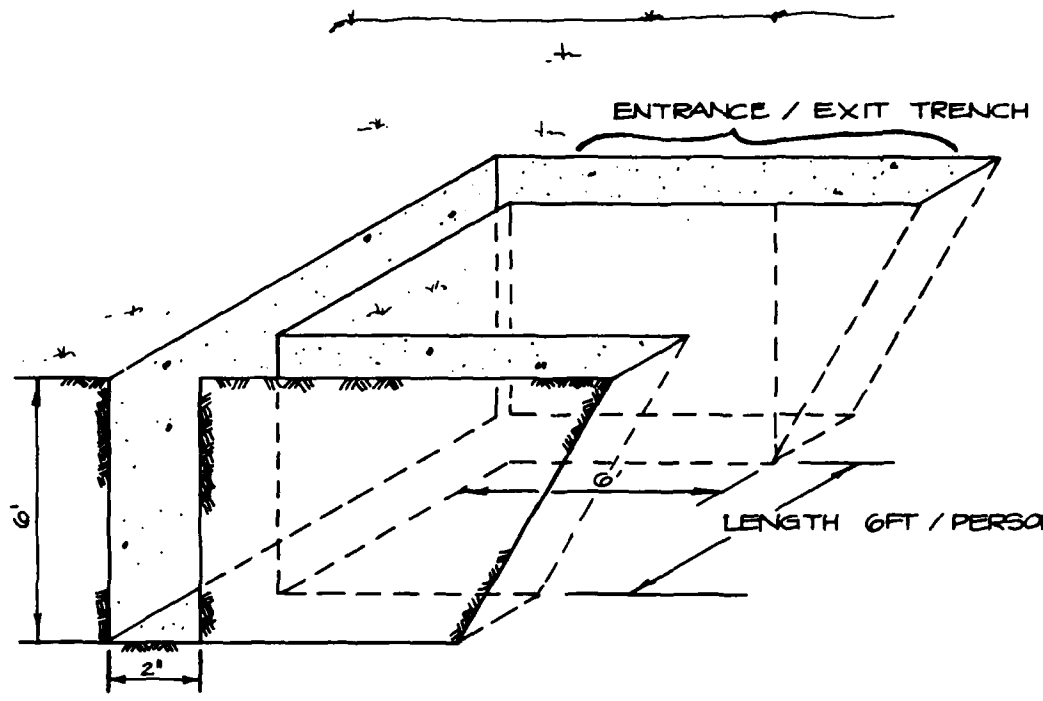
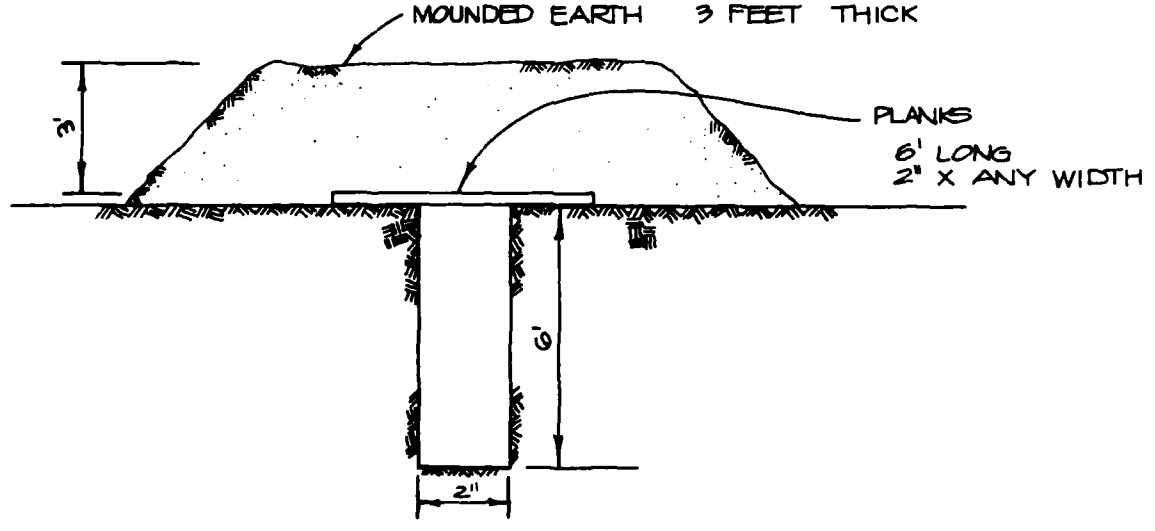


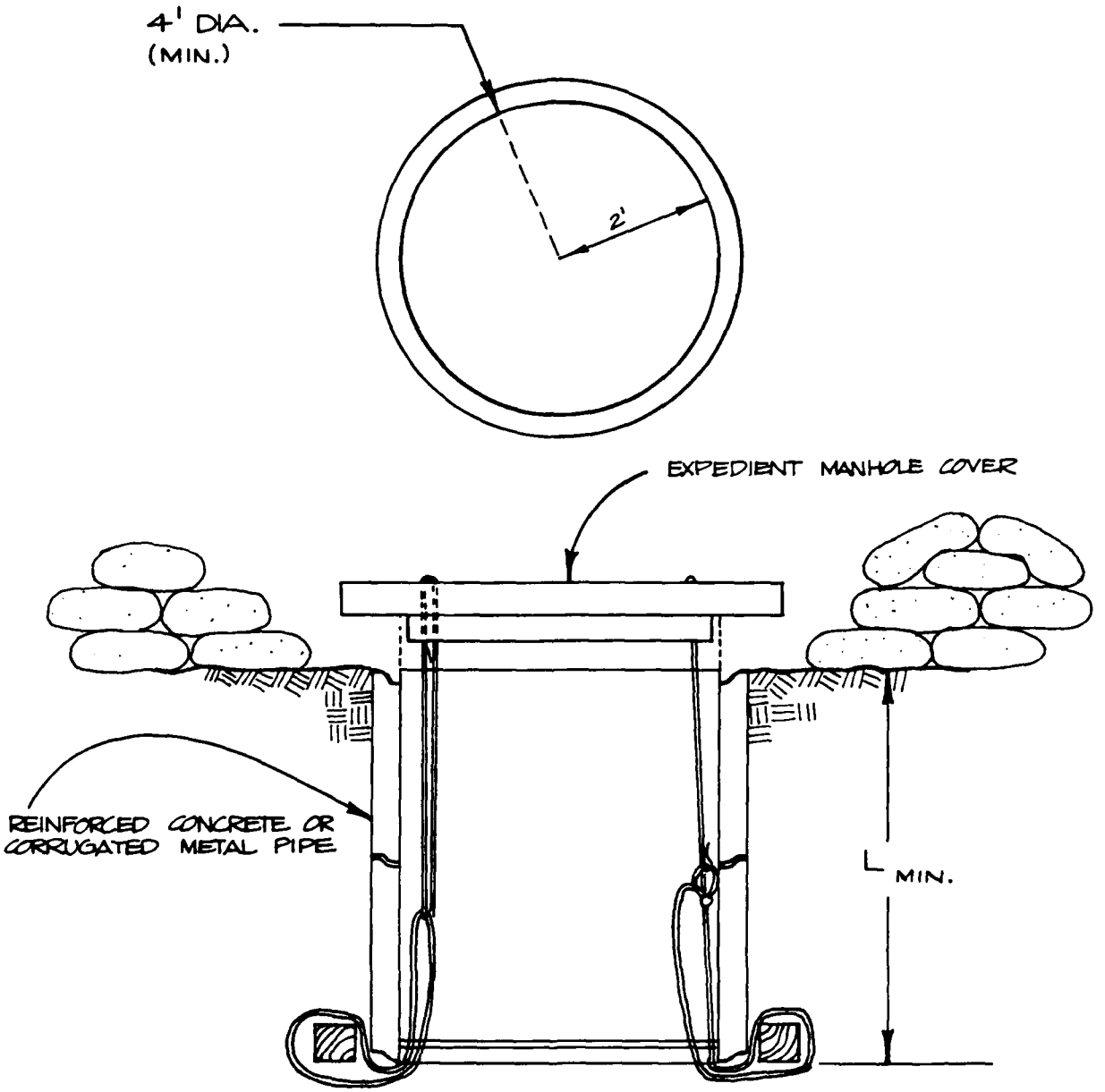
TRENCH SHELTER PRIOR TO PLACING PLANKS AND MOUNDED EARTH



SIZE TRENCH FOR NO. OF PEOPLE - 6 LIN. FEET / PERSON

NOTES: 1. Place planks.
2. Place newspaper, plastic sheets, etc. to keep dirt from falling through cracks.
3. Place 3 ft. of dirt over planks.

Fig. D-10. Expedient Host Area Trench Shelter.



4' DIA. - 1 MAN SHELTER (L_{MIN}=6'-0")
5' DIA. - 2 MAN SHELTER (L_{MIN}=7'-0")
6' DIA. - 3 MAN SHELTER (L_{MIN}=7'-0")
7' DIA. - 4 MAN SHELTER (L_{MIN}=7'-0")
8' DIA. - 5 MAN SHELTER (L_{MIN}=6'6")

Fig. D-11. Fabricated Manhole Type Shelter.

SUMMARY

The development of radiation protected Host Area shelters has been prestated in this section. Many approaches to shelter selection and upgrading have been discussed. The selection, implementation, and upgrading of the shelters discussed herein have been summarized on the following three pages:

Checklist A provides a summary of shelter selection options.

Checklist B provides a chronological sequence for burial of an expedient shelter.

Table D-3 provides an estimate of man-hours that may be necessary to implement burial, upgrading, and stocking for the majority of options discussed.

Resource lists to assist in upgrading are included for stud wall and post and beam upgrading alternatives.

TABLE D-3: EXPEDIENT HOST AREA SHELTER PREPARATION TIME

Expedient Shelter Option	Underground Burial	Access/Ventilation Floor Construction	Shelter Supplies
Railroad Cars:			
Refrigerator	3 men, 16 hrs	3 men, 24 hrs	2 men, 10 hrs
Box Cars	3 men, 16 hrs	3 men, 30 hrs	2 men, 10 hrs
Caboose	3 men, 12 hrs	3 men, 20 hrs	2 men, 10 hrs
+ (upgrading)	2 men, 20 hrs		
Passenger Cars	4 men, 20 hrs	3 men, 30 hrs	2 men, 10 hrs
+ (upgrading)	3 men, 8 hrs		
Storm Drainage Facilities:			
Manholes	N/A	1 man, 8 hrs	1 man, 8 hrs
Large Pipes	(Closures) 4 men, 20 hrs	4 men, 24 hrs	2 men, 10 hrs
Box Culverts	(Closures) 4 men, 30 hrs	4 men, 30 hrs	2 men, 10 hrs
Maritime Shipping Containers	3 men 12 hrs	3 men, 20 hrs	2 men, 10 hrs
+ (upgrading)	1 man, 8 hrs		
Concrete Utility Vaults	3 men, 10 hrs	3 men, 10 hrs	2 men, 10 hrs
Trailer Truck Van Bodies	3 men, 10 hrs	3 men, 10 hrs	2 men, 10 hrs
+ (upgrading)	2 men, 8 hrs		

CHECKLIST A

EXPEDIENT SHELTER IMPLEMENTATION ANALYSIS

Number of Host Area Personnel
Needing Shelter _____

Shelter Selection Options:

1. Available basement area? _____ Is it upgradable? _____ If not, locate expedient shelter option.
2. Expedient shelter option:

   (a) Existing buried structure:

   Onsite _____

   Adjacent off site _____

   (b) New option to be buried:

   Tank _____

   Railcar _____

   Vault _____

   Container _____

   Other _____

3. Transportation to site:

   Easily relocated _____

   Special transportation required _____

4. Type of transportation equipment needed:

   (a) _____

   (b) _____

5. Locked secure storage for resources and stocking _____

EXPEDIENT SHELTER STRUCTURE IMPLEMENTATION CHECKLIST FOR BURIAL

Expedient shelter has been delivered to Host Area site for burial.

(1) Select location for burial away from buildings that may collapse or from facilities that may inundate or damage entry or ventilation equipment.

(2) Excavate for shelter using:
- (a) Backhoe
- (b) Front endloader
- (c) Crawler tractor
- (d) Combination of above.

(3) Excavate for entries — Two are required.

(4) Provide all modifications to structure for entries and ventilation, and clean structure interior.

(5) Set structure in excavation with crane or other lift equipment.

(6) Install entry, ventilation, and closure structures.

(7) Install interior floor, if required.

(8) Provide all large shelter stock items prior to backfilling.

(9) Backfill and berm structure; excavate waste disposal area.

(10) Finish stocking shelter, if required.

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		

RESOURCE LIST

	Required	Quantity	Available
1.	Posts, steel or wood		
2.	Beams, steel		
3.	Nails		
4.	Hammer		
5.	Saw		
6.	Wedges		
7.	Tape measure/yardstick, etc.		
8.			
9.			
10.			

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